DATA PROCESSING

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Current accounts on a computer

As an experiment, Martins Bank Limited used a Ferranti Pegasus computer to perform all the routine current account book-keeping work of a branch bank

As a result of the experiment, Martins Bank have ordered a Ferranti Pegasus 2 computer equipped with magnetic tape. It is estimated that this machine will be capable of keeping the records of 30,000 banking accounts. The computer is to be installed at a computing centre to which details of transactions are to be sent daily by the branch banks in the neighbourhood. Here records of customers' accounts are to be kept on two magnetic tape files. At the branch banks, details of daily transactions are to be recorded in 5-channel punched paper tape as a by-product of existing listing and proving operations.

After the banks have closed for the day, the punched tapes will be sent to the computer centre, where the information on the magnetic tape files will be up-dated accordingly. Printed records showing the current balance for each account and unusual features of any account, such as an excessive overdraft, will be returned to the local banks the same evening. Customer statements will also be prepared on the appropriate dates and returned with the other documents. In addition, the computer will produce statistics for the use of the bank managers.

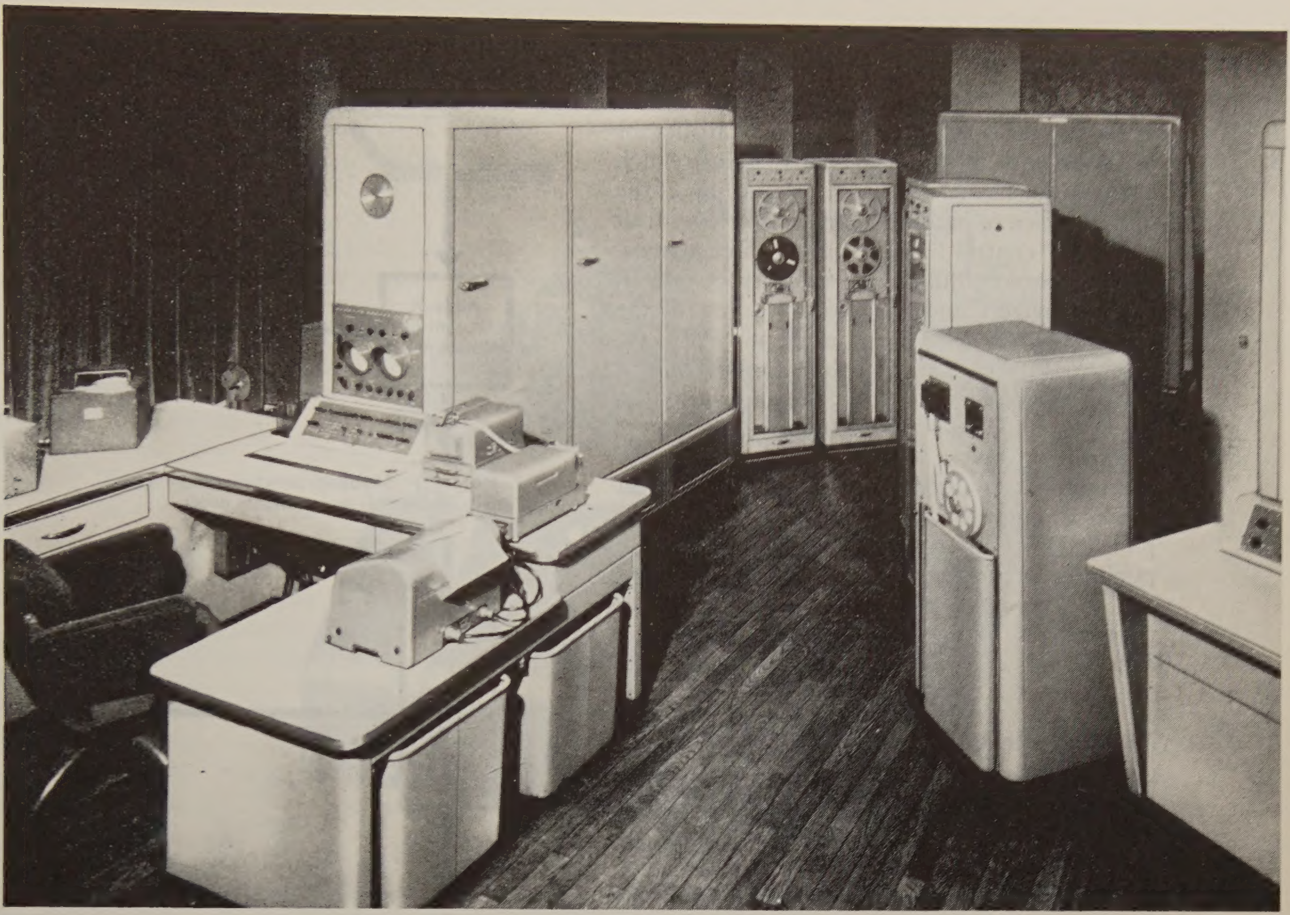
To gain practical experience and confirm that the scheme was feasible, during January, 1960, Martins Bank used the Ferranti Pegasus service computer in London to keep records of all the accounts administered by their South Audley Street branch. After the experiment had served its purpose, it was discontinued in order that work could be concentrated on preparing for the Bank's own Pegasus installation.

It is expected that the computer, manned by a staff of five, will be able to perform the work now done by a staff of 100 equipped with 80 business machines

MARTINS are the first bank in Great Britain to have actually kept the current account records of a branch bank on a computer. Every day, for a month, the accounts of a small branch were up-dated. The computer performed all the book-keeping operations necessary, printed customers' statements automatically when they became due and provided management with a daily printed record of the current balance of each account, together with a control list that specified the important features of any individual accounts that needed special attention, such as excessive overdrafts or incorrect entries.

This work was performed on the modified Pegasus I computer equipped with magnetic tape that is installed at the Ferranti service centre in London. It was an experiment carried out to confirm that bank records could be kept by a computer.

As a result of the success achieved, Martins Bank have ordered a Ferranti Pegasus 2 computer which is scheduled to be delivered early in 1961. Incidentally, this Pegasus 2 will be able to complete the book-keeping calculations in 70 per cent of the time now taken by the modified Pegasus 1. Seventeen minutes were required each day to up-date the accounts of the South Audley Street branch. This includes the time necessary for preparing the computer. Obviously, when more accounts are handled, processing speeds will be higher, because proportionately less time will be spent on preparing the computer. It is expected that, with the



As an experiment, for one month, the current account records of the South Audley Street branch of Martins Bank were kept on the Ferranti Pegasus service computer

faster computer and an operating staff of five, accounts will be up-dated at the rate of 6,000 an hour.

To provide an effective book-keeping service, accounts have to be up-dated after 3 p.m. when the banks have closed for the day, and the results printed and delivered to the branch managers before the banks open again next morning. In effect, this means that the computer can only be employed on current account book-keeping for one shift a day, but even so, after allowing for operational contingencies, it is estimated that the Pegasus 2 computer will be capable of keeping the accounts of approximately 30,000 customers. In addition, the computer will be available to perform other work throughout the remainder of the working day.

At the moment the services of 80 business machines and a staff of 100 are needed to keep the records of 30,000 accounts. Consequently, not only will the computer free a large number of staff for other work, but also the demands on office space will be reduced considerably. Because of the severe shortage of bank staff, nobody will be made redundant when the computer is introduced. In fact, Martins Bank propose to take advantage of the situation to improve the personal service offered to customers.

The data processing installation ordered comprises a basic Pegasus 2 computer plus two Ferranti 300-characters a second punched tape readers, a 60-characters a second tape punch, a 300-characters a second punch, a magnetic tape control console and four magnetic tape units. The complete installation will cost about £150,000 and will be the 33rd Pegasus computer installation delivered by Ferranti. As the computer can handle 30,000 accounts and this is more than any one branch is ever likely to control, the machine is to be placed in a convenient geographical location within easy reach of a number of branches.

The experimental book-keeping programme performed on the Pegasus 1 takes care of eleven main accounting procedures and two subsidiary ones. Among the operations performed are: the entry of normal credits and debits, correction of faulty entries, alteration of basic account information, addition of new accounts, deletion of closed accounts, accumulation of statistics for management, detection of debits against which a stop order has been placed, comparison of the final balance of each account against overdraft and other control limits, printing of customers' statements, accumulation of statistics for branch bank managers and the daily printing of the current balance of every account. All data submitted from the branch are punched in paper tape and results are also recorded in paper tape.

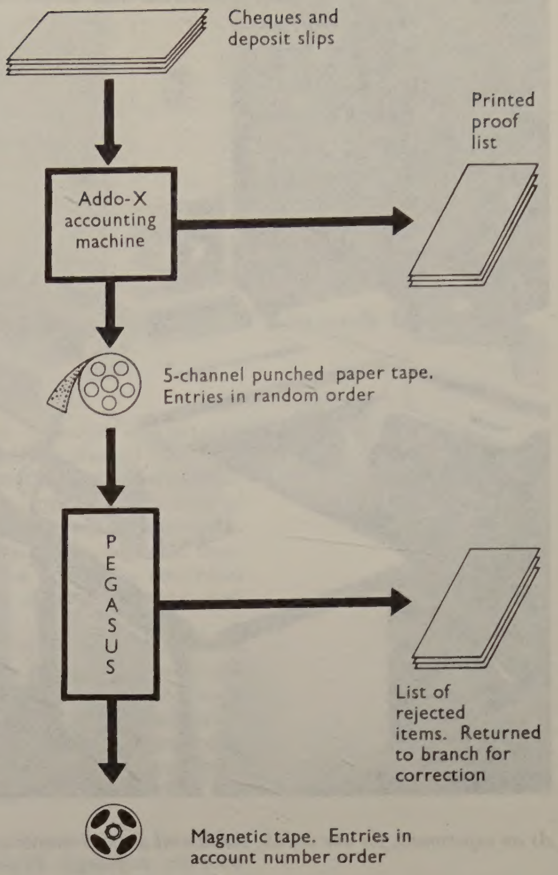
Paper tape was chosen as the medium of communication for three reasons: its low cost (approximately 3s. 6d. per 1,000 feet), data punched in tape can be transmitted over existing public or private teleprinter systems and data can be recorded in tape automatically as a by-product of a normal accounting machine operation.

Account numbers

At the branch, each customer's account is given a 7-digit code number which is printed together with his name on all cheques supplied for his use. The account number is constructed in such a way that the computer can check the figures punched in the tape and confirm that it is a valid account number. This is done by making the seventh digit in each number a check digit. If an error is made in punching, the check digit will indicate this. Incorrect digits and transpositions can all be detected by this method. This is one of many checks performed to eliminate the possibility of an incorrect entry.

Every day, all the documents received at the branch that affect the status of the customers' accounts—mainly cheques and deposit slips—are listed. Documents, of course, are received from two sources. Customers pay in cheques accompanied by deposit slips—amounts to be credited to their accounts—whereupon cheques not belonging to the branch are forwarded to the Bank's central clearing department and, in return, the branch receives cheques from the clearing department that have been submitted for payment through other banks—values to be debited.

Documents from both sources are listed at the branch and totals are derived for individual batches. These totals are then compared or "proved" against similar control totals obtained during listing operations performed earlier in the data processing sequence. This is one of the standard checking procedures already performed in banks and the information about current transactions required for the computer bookkeeping routine can conveniently be captured at this stage.

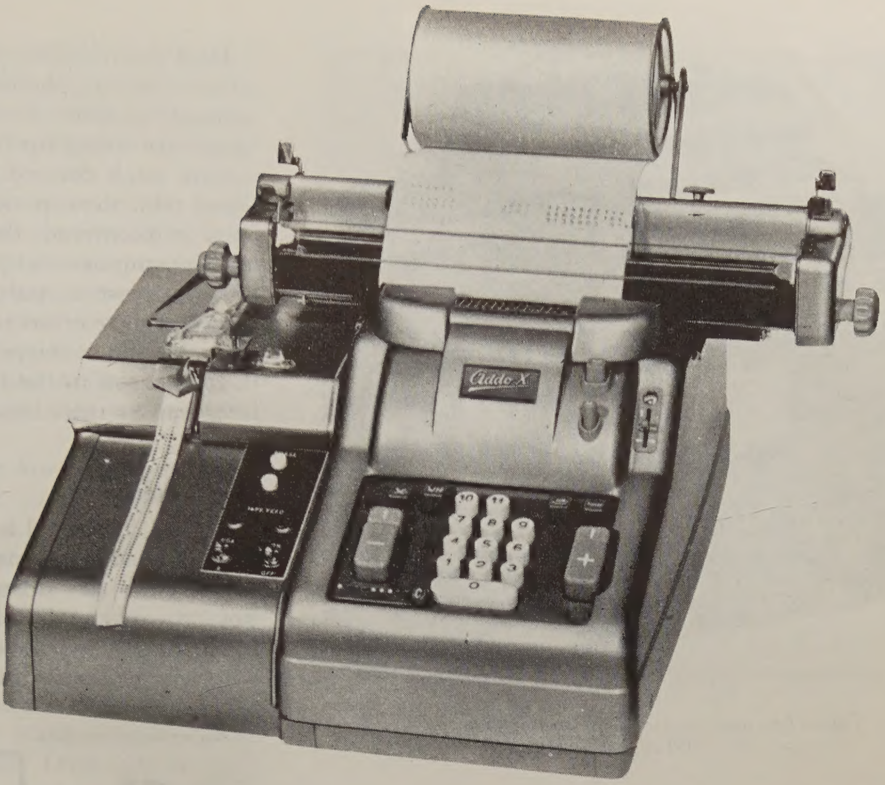

Cheques and deposit slips
Printed proof list
Addo-X accounting machine
5-channel punched paper tape. Entries in random order
PEGASUS
List of rejected items. Returned to branch for correction
Magnetic tape. Entries in account number order

Capturing and sorting transaction data

A new design of Addo-X accounting machine equipped with a 5-channel paper tape punch was used for this work. Data entered on the keyboard are printed on a tally roll and simultaneously punched in the paper tape. Details recorded in the tape are the account number, a simple description of the transaction and the amount. The machine is equipped with a register in which batch control totals are compiled and these totals are also punched in the tape. Subsequently these control totals are used by the computer to confirm that the basic data have been correctly read into the machine.

Also recorded in the tape are details of new accounts that have been opened, old accounts that have been closed and any amendments or corrections to existing records.

The branch bank is responsible for the accuracy of the information supplied to the computer and it has been stipulated that



Data entered on the keyboard of this Addo-X accounting machine are punched in paper tape

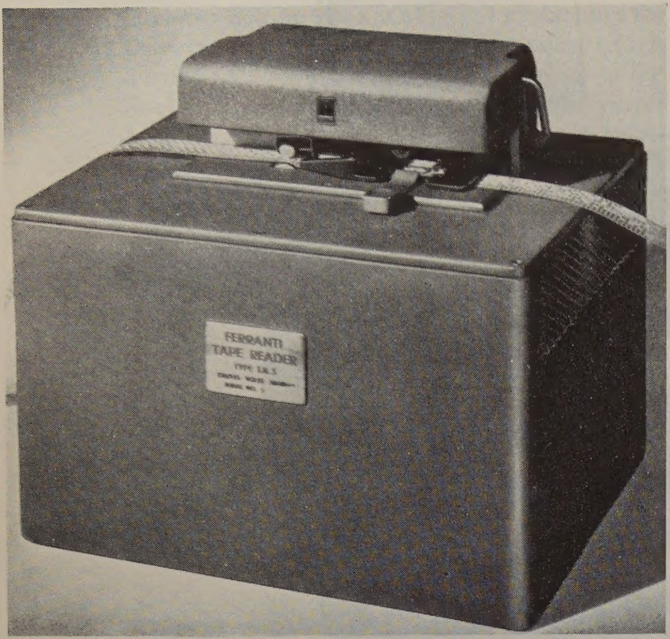
erasures are not allowed. Incorrect data are identified by punching an error code in the paper tape. This code is recognized when the tape is read and the information is ignored. Experience indicates that the persons supplying the information to the computer have to be trained to be meticulous and accurate, and that these lessons are best learnt by organizing a series of dummy runs during which information is prepared as if a computer operation were to

MARTINS BANK LIMITED FERRANTI PEGASUS 2 COMPUTER INSTALLATION

The machine ordered by Martins Bank is a standard Pegasus 2 equipped with two photoelectric punched tape readers, two tape punches (a Teletype Model 60 and a Creed Model 3000), a magnetic tape control console and four magnetic tape units. Provision has been made for the system to be extended as the volume of work to be handled increases. In addition, provision has been made to fit a magnetic-ink character-recognition device, should this be required, once the common language code to be adopted by the British Banks has been agreed.

PEGASUS 2 CHARACTERISTICS

Number system: binary
Mode of operation of arithmetic unit: serial
Average times for arithmetical operations:
+ 0·3 milliseconds (0·0003 second)
× 2 milliseconds (0·002 second)
÷ 5·5 milliseconds (0·0055 second)
Type of instruction: single address
Word length: 39 bits
Quick access store: nickel delay lines of 55 words capacity
Intermediate store: nickel delay lines of 256 words capacity
Main store: magnetic drum of 8,960 words capacity
Backing store: magnetic tape. Four units fitted. Data are recorded in blocks of 32 words each and a block can be transferred between the tape and the buffer store in 55 milliseconds (0·055 second)
Data input: punched paper tape read at 300 characters a second
Data output: 5-channel paper tape punched at 60 characters a second or, 300 characters a second. Data punched in tape are converted into print at the rate of 10 characters a second



Transaction data are read from punched tape at the rate of 300 *characters a second*

follow. These entries are then examined in detail to detect errors and inconsistent operational procedures.

From this it is clear that the branch banks remain in full control of their accountancy procedures. The computer merely processes the data submitted at high speed; the administration of the accounts remains the direct responsibility of the branch.

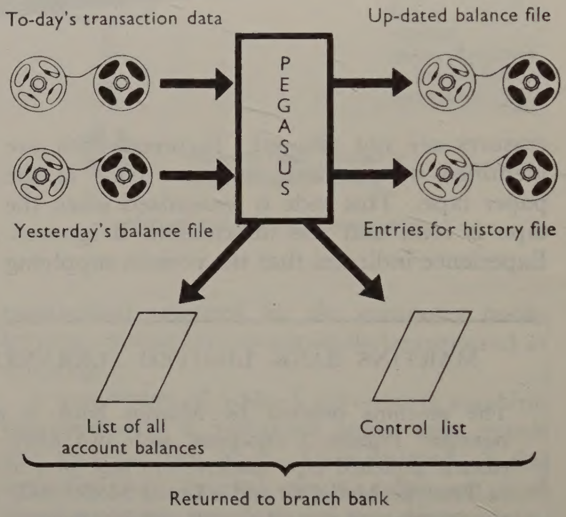
As the documents arrive throughout the day, the work of transcribing transaction data proceeds and is completed by 3.30 p.m. at the latest—half an hour after the banks close. The original documents are retained at the branch and only the rolls of punched paper tape are sent to the computing centre. In the case of the initial experiment, because the South Audley Street branch is so close to Ferranti's London computer service centre at Portland Place, the tapes were delivered by messenger.

Naturally, details of the transactions are recorded in the paper tape in the order in which the documents relating to them are received; therefore the first job for the computer is to sort the individual entries into account number sequence. While this is being done, the computer also checks that the data read from the punched tape are consistent, accurate and contain the correct number of items arranged in the correct order.

Data are read at a speed of 300 characters a second by a photo-electric reader. Every account number is checked and individual values are totted up by the computer, and the control totals derived in this manner are compared with those punched in the tape. If any error is discovered, the information is rejected by the computer and punched in paper tape by one of the two output punches. Later a printed record of these errors is produced by passing the tape through a teleprinter. This document is then returned to the branch so that the errors listed can be traced and corrected.

Sorting entries

Entries confirmed as being correct, however, are sent to the magnetic drum of the Pegasus where they are stored. When the available storage capacity is full, the entries are transferred from the drum in account number order and recorded on a reel of magnetic tape. Once the current day's entries have been arranged in account number sequence on magnetic tape, everything is ready for the up-dating runs.



Up-dating the balance file. A printed list of all account balances is produced during this operation

Data concerning customers' accounts are held in account number order on two magnetic tape files—the balance file and the history file. These two files are kept permanently at the computing centre.

On the balance file, the following data are recorded for each account: account number, customer's name, current balance, account limits, details of stopped cheques and various accumulated statistics for the use of management, such as the average balance of an account over a specified period. This last figure is also used to compute bank service charges.

On the history file are recorded for each account: the account number, customer's name, periods at which statements of account are to be rendered, balance and date printed on last statement, and the date, brief description and amount of each transaction that has occurred since the last statement was supplied.

Both these magnetic tape files are up-dated once a day.

The balance file is the first to be amended. All four magnetic tape units fitted to the Pegasus computer are used for this programme. Two provide input data and the remaining two record results. The magnetic tape containing the current day's transactions and the reel containing the previous day's balance file are fitted to the input units and two blank reels of magnetic tape are fitted to the output units.

Reels containing either 600 feet or 1,800 feet of magnetic tape are used. Data are recorded in blocks of 32 computer words and each block contains the records of two accounts. On average 10,000 accounts can be kept on 1,800 feet of tape.

After the programme has been read into the computer, the account numbers on the balance file are examined in turn and compared with the first account number recorded on the transaction data tape. If these two numbers do not agree, all the items associated with the particular account number on the balance file are transferred unaltered and recorded on the output tape which is to be the new balance file. While this transfer is taking place the account number, customer's name and the balance are punched in paper tape by one of the output punches.

Should the account numbers agree, the two sets of figures are combined, the new balance is calculated and the revised data are recorded on the output tape. Again, the account number, customer's name and closing balance are punched into paper tape. Furthermore, the new closing balance is checked against the overdraft and any other control limits and, whenever a balance exceeds the limits set, these data are punched in a second paper tape by the second output punch. Also, debit entries are checked against the "stop" list and rejected if affected. Details of rejected items are punched in the second tape.

Branch managers may, at their discretion, place a "stop" order against any particular account. All entries relating to these accounts will then be rejected automatically by the computer enabling the manager to administer them personally.

It is at this stage in the data processing sequence that details of new accounts are introduced into the balance file and data regarding closed accounts are removed. Once again, full details of both these operations are punched in the second paper tape.

While this is going on, selected information is being recorded on a second magnetic tape. Data recorded are the date, the account number, and a brief description and the amount of each transaction, together with any corrections to previous figures that have been submitted by the branch. These data are basically the same as the entries on the transaction data tape except that details of account limits and similar confidential managerial control information are excluded. This tape is used in the next data processing sequence to up-date the history file.

Results

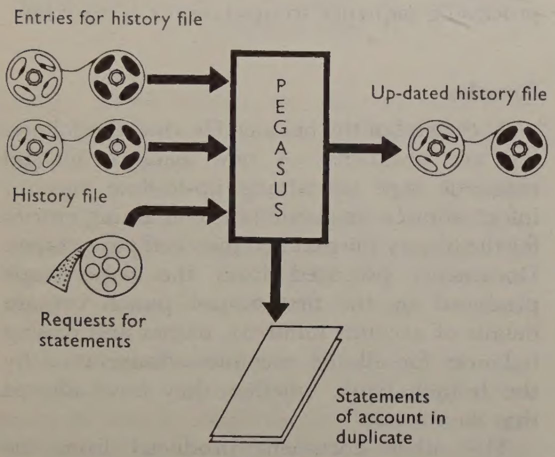
At the end of the balance file run, the following are produced: A new balance file on magnetic tape containing up-to-date account information, a magnetic tape containing entries for the history file and two punched paper tapes. Documents prepared from the paper tape produced by the first output punch contain details of account numbers, names and closing balances for all the accounts administered by the branch bank, whether they have altered that day or not.

The other document produced from the second punched tape is called the control list. It contains details of all new accounts opened, old accounts closed, overdrafts that have exceeded specified limits, cheques on which payment has been stopped and details of those accounts which the branch manager wishes to handle personally.

Copies of both these documents are sent to the branch managers and, since they arrive before the start of business next morning, time is available for action to be taken where this is necessary.

Finally, the history file is up-dated. Three magnetic tape units are used for this programme. Input data are obtained from two magnetic tapes—the current history file and the new entries for the history file that were recorded on tape during the balance file programme just completed. Once again the account numbers on the two input tapes are compared. If the numbers do not agree, the data from the history file are transferred unaltered and recorded on the output tape which is to be the new history file. Where the account numbers agree, the data from the history file are transferred and recorded on the output tape, as before, and the date, brief description and value of each transaction obtained from the second input tape are added to the end of the account record in the correct order.

After this operation, the computer determines whether the customer is due to receive a statement of account and, if so, the appropriate details are punched in paper tape. In addition to the statements supplied at fixed intervals customers can obtain special statements whenever they request them. The account numbers of persons requiring these additional statements are punched in a paper tape which provides a third source of input data for the history file programme. Whenever one of these accounts is reached, the relevant details are punched in the output tape.



Up-dating the history file

Statements are printed on continuous stationery by feeding the output tape through a teleprinter. Two copies are made—the top copy for the customer and a carbon copy for the branch bank. This operation concludes the current account book-keeping work performed on the computer.

It can be appreciated from this description that branch banks are provided with all the information needed to administer the current accounts. Every day the banks receive printed lists of all accounts and current balances. All exceptional activities in individual accounts are drawn to the attention of the staff, since full details are printed out on the control lists and, in addition, managers are provided with statistics indicating the progress of business.

By operating this system, Martins Bank will relieve their banking staffs of a considerable burden of routine accountancy chores, leaving them free to concentrate on improving the service given to the customers.

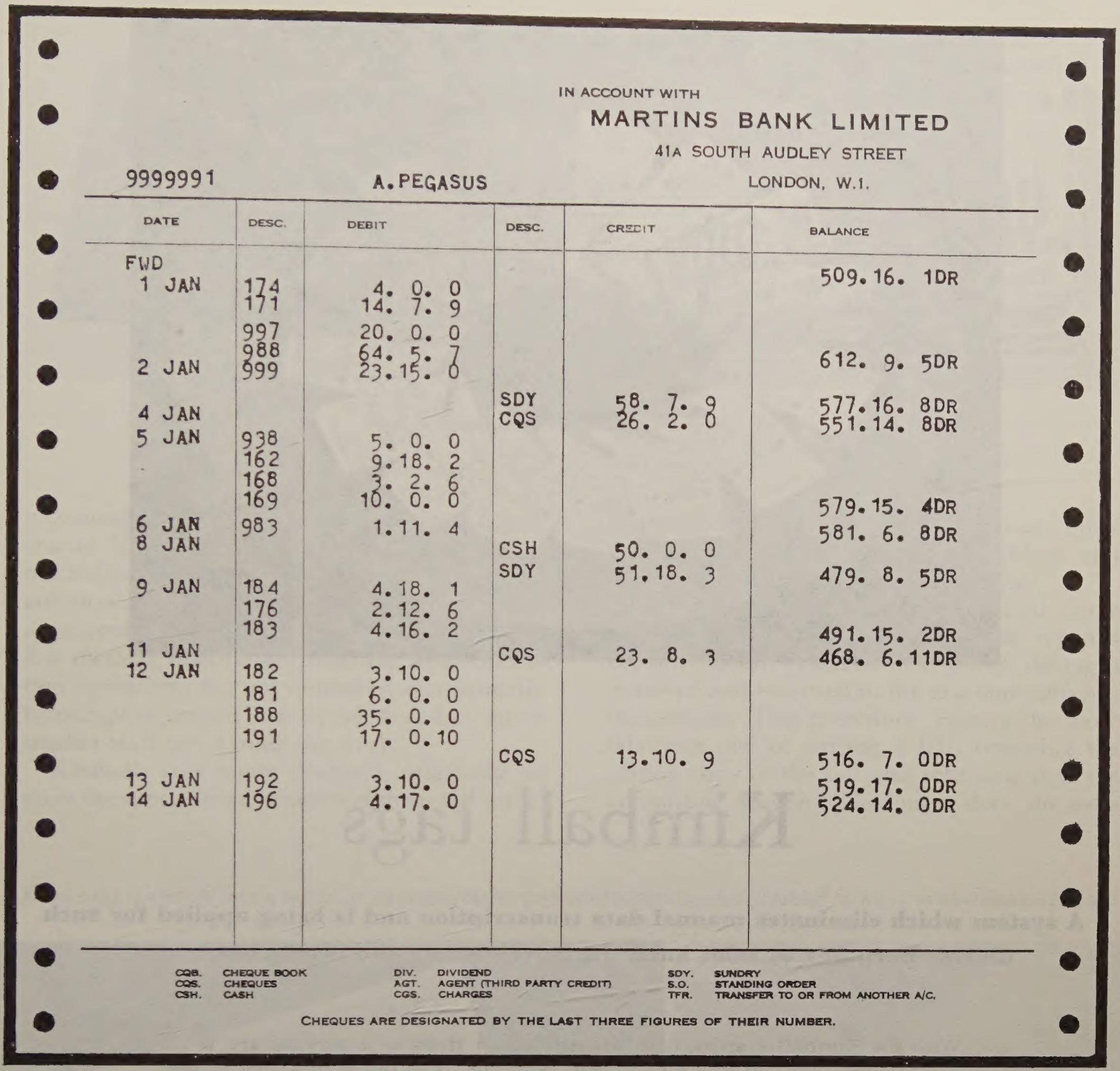
Customers' cheques

As far as the customer is concerned, the only detectable differences are that his cheques have his account number and name printed on them. And, if a special statement is requested, it cannot be prepared at once, but will be available when the bank opens the following morning.

The purpose of the experiment with the accounts of the South Audley Street branch was, of course, to prove with "live" rather than fictitious data that the methods devised were both feasible and practical; that the computer could in fact perform the day-to-day routine book-keeping work both efficiently and accurately. Naturally, during the period of the experiment, normal clerical records were also maintained. The only errors detected in the computer operations were almost entirely due to human failures—usually the supply of inaccurate data, wrong account numbers and the like.

Data processing team

Another purpose was also served by the experiment. As the number of accounts handled was small, the members of the team developing the computer system were able to follow and administer the entire operation in detail. They learnt the requirements of branch banking and how to satisfy these requirements. Consequently, the data processing team now possesses a much better appreciation of the problems facing branch bank managers. As a result of the experience gained, the original programmes will be modified in readiness for the time when the Pegasus 2 computer is delivered to Martins Bank early next year. From this experiment, what might now be termed the conventional lessons of data process-



IN ACCOUNT WITH
MARTINS BANK LIMITED
41A SOUTH AUDLEY STREET
LONDON, W.1.

9999991 A.PEGASUS

DATE	DESC.	DEBIT	DESC.	CREDIT	BALANCE
FWD					509.16. 1DR
1 JAN	174	4. 0. 0			
	171	14. 7. 9			
	997	20. 0. 0			
	988	64. 5. 7			
2 JAN	999	23.15. 0			612. 9. 5DR
			SDY	58. 7. 9	577.16. 8DR
4 JAN			CQS	26. 2. 0	551.14. 8DR
5 JAN	938	5. 0. 0			
	162	9.18. 2			
	168	3. 2. 6			
	169	10. 0. 0			579.15. 4DR
6 JAN	983	1.11. 4			581. 6. 8DR
8 JAN			CSH	50. 0. 0	
			SDY	51.18. 3	479. 8. 5DR
9 JAN	184	4.18. 1			
	176	2.12. 6			
	183	4.16. 2			491.15. 2DR
11 JAN			CQS	23. 8. 3	468. 6.11DR
12 JAN	182	3.10. 0			
	181	6. 0. 0			
	188	35. 0. 0			
	191	17. 0.10			
			CQS	13.10. 9	516. 7. 0DR
13 JAN	192	3.10. 0			519.17. 0DR
14 JAN	196	4.17. 0			524.14. 0DR

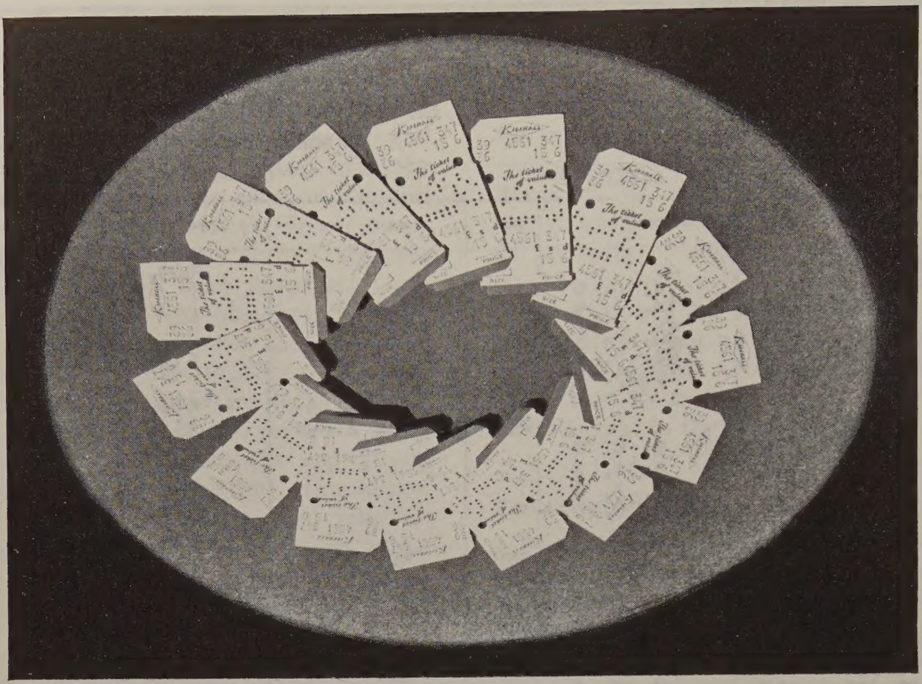
CQB.	CHEQUE BOOK	DIV.	DIVIDEND	SDY.	SUNDRY
CQS.	CHEQUES	AGT.	AGENT (THIRD PARTY CREDIT)	S.O.	STANDING ORDER
CSH.	CASH	CGS.	CHARGES	TFR.	TRANSFER TO OR FROM ANOTHER A/C.

CHEQUES ARE DESIGNATED BY THE LAST THREE FIGURES OF THEIR NUMBER.

A customer's printed statement of account

ing were learnt. These are that the most difficult part of any application is to decide what to do and how to do it. Once this has been settled, the writing and proving of the computer programme, if tedious, is relatively simple and straightforward. The programmes for the banking application were written and fully tested within eight months following an investigation period extending over three years.

Having successfully developed the bookkeeping programmes, the research staff of Martins Bank are already actively investigating the application of a computer to other problems. A development that may lead to a modification of the data processing procedures set out in this article is the adoption of a printed common language code by the British banks. Almost certainly this code will consist of characters printed in magnetic ink, but which one of the many codes proposed will finally be adopted is still the subject of study by the Electronics Sub-committee of the London Clearing Banks. A decision on this matter is likely to be made later this year and a spare data input channel is to be provided on the Pegasus 2 computer to which the appropriate design of magnetic character reader can be connected, should this be considered necessary.



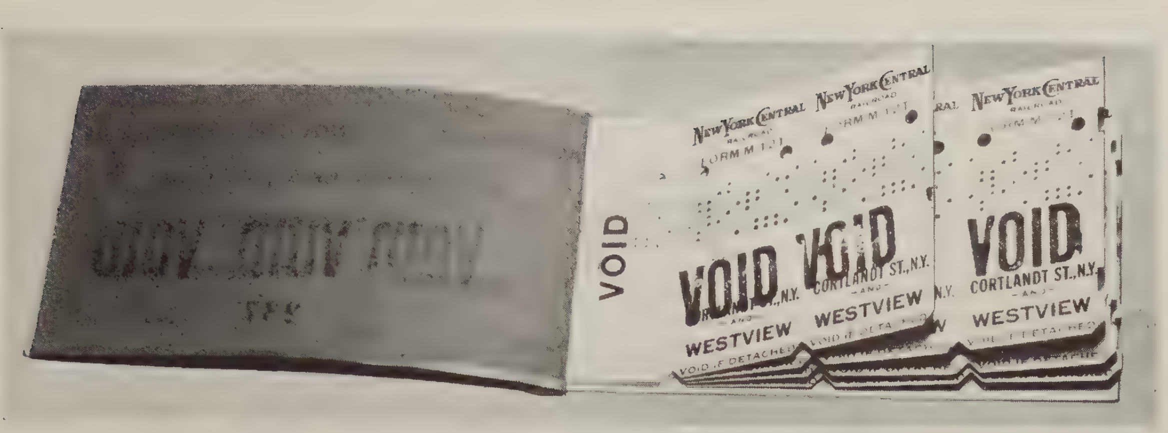
Kimball tags

A system which eliminates manual data transcription and is being applied for such diverse purposes as sales analysis, travel tickets and production control

With the Kimball system, data identifying an item or a service are both printed and punched in a small cardboard tag. The tag is attached to the product it identifies and, when, say, the item is sold, the tag is removed and returned to the data processing section. Here, the data recorded as perforations in the tag are automatically read and transcribed into punched cards which are then handled in the usual manner. In this way a machine procedure is substituted for a manual clerical system, time is saved and inaccuracies are avoided. Applications of the Kimball system and the equipment now available are described in this article

In commercial data processing the biggest single problem is to obtain accurate basic data and to transcribe this information—without error—on to a document that can be read mechanically. The Kimball tag is one method of ensuring this. A Kimball tag is a small piece of white card measuring $1\frac{1}{8}$ inches by $2\frac{5}{16}$ inches. Data are recorded in the central area of the tag as a pattern of very small punched holes. The information punched is also printed on the tag so that it can be read both visually and mechanically.

With the Kimball system, basic data concerning a product or a transaction are recorded on a tag which is attached to and travels with the product. Later the tag—or a part of it—is removed and returned for processing, either when a sale is made or, in the case of some other



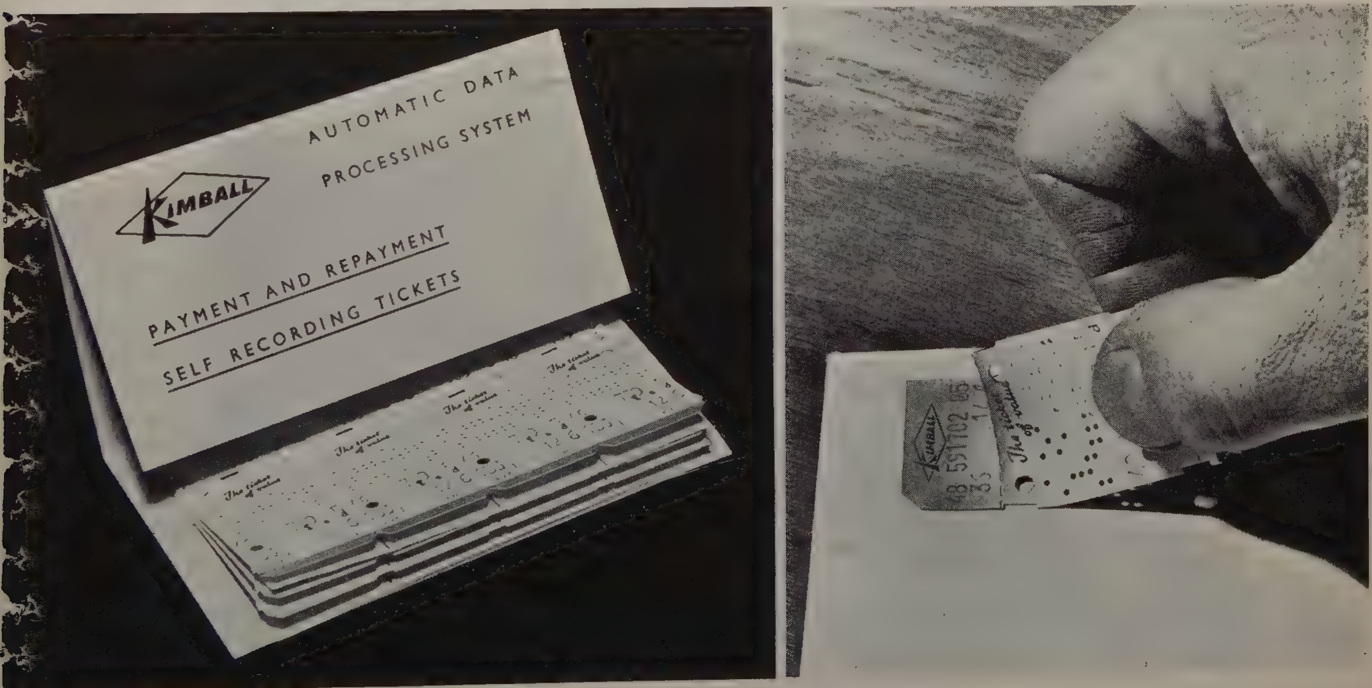
Tags, used as railway tickets, bound in book form

transaction, when a certain stage in the procedure is reached. All pertinent information needed for the data processing sequence are read automatically from the tag and transcribed into a conventional 80-column punched card. With this method, manual keypunching and verification operations are not necessary, consequently transcription errors are avoided and a much smaller staff can handle the work.

Kimball tags were designed originally to meet the special requirements of the retail trade, but obviously they can be used for many other purposes—for example, as travel tickets and notification of hire-purchase payments.

In those retail organizations that have adopted the Kimball system, the tag replaces the price ticket. When an item is sold, the tag is removed and returned to the machine accounting section. This procedure replaces the more laborious one of writing a bill, removing the carbon copy of the bill and returning it to the accounting section. No longer does the sales

When a tag is removed from a booklet, or an article, the top perforated portion may be left behind for record or identification purposes



staff waste time completing clerical records and, more important still, the hand-written sales bill, usually a prolific source of errors, is eliminated.

Another advantage of the Kimball system is that a set of identical tags can be attached to and travel with each item. Then, at each stage where control information is required, a tag can be torn off. Tags may also be perforated laterally so that, when the main punched portion is removed, a printed stub is left on the item for identification purposes.

Damaged tags

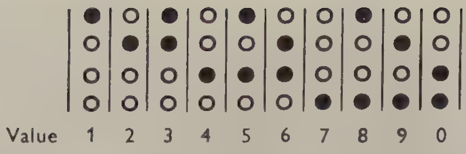
Being made from card 0·013 inches thick, the tags can withstand rough handling. If, nevertheless, a tag is damaged or defaced to such an extent that the punched data are affected, the automatic reader will reject the tag and consequently draw the attention of the machine accounting staff to the mutilation.

Tags may be fixed to the item they identify by any of the standard methods such as tying, pinning, gluing, stapling or sewing.

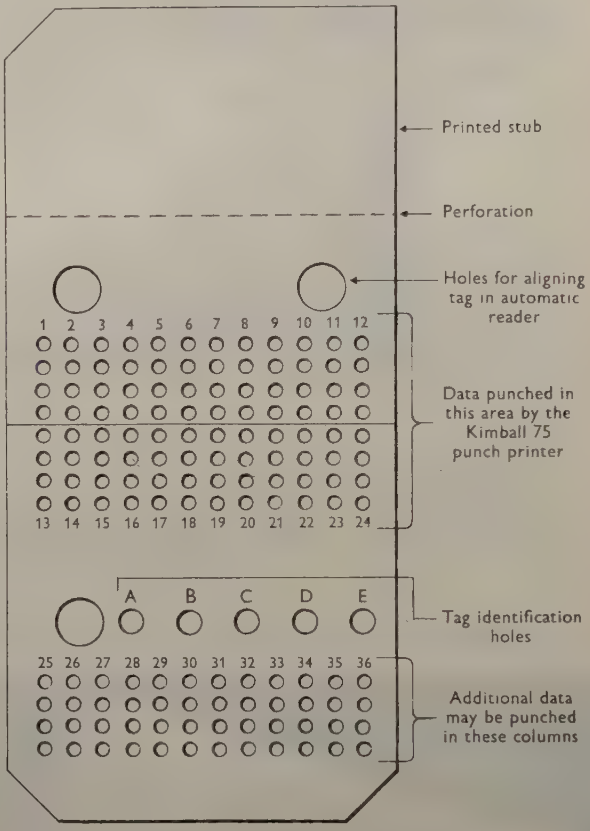
All the data are punched in an area of one square inch in the middle. A four-bit decimal binary code* is used. Twenty-four columns are available and one decimal digit is recorded in each column. A small hole, $\frac{1}{32}$ inches in diameter, can be punched in any one of four vertical positions in each column. The decimal values given to these four positions, reading from top to bottom are 1, 2, 4 and 7. Thus any decimal figure is represented by punching one or, at the most, two holes in each column as shown in the illustration. Holes punched in the upper two positions, represent 3, in the top and bottom positions 8, and so on. Holes are punched in positions 4 and 7 to represent the numeral 0 or to indicate a blank column. Every column must therefore contain at least one or two punched holes.

Alignment

Larger holes ($\frac{1}{8}$ inch in diameter) are punched at three of the corners of the recording area. The two holes on the left are used to locate the tag accurately under the data sensing head of the reading machine. They also ensure that the tag is the right way up and the proper way round so that it is impossible for the holes punched in the columns to be interpreted incorrectly. In addition to the 24 columns in the middle, a further 12 columns of numerical data can be punched in the lower part of the tag. This area is reserved for information that is added at a later stage in the data processing sequence. For example, when a product is sold and the tag removed, additional data may be entered in it to identify the assistant making the sale. By recording associated data in this way, more comprehensive business statistics can be obtained and more complete analyses performed.



Punched hole code used with Kimball tags



Design of Kimball tag showing the 36 columns in which data may be punched

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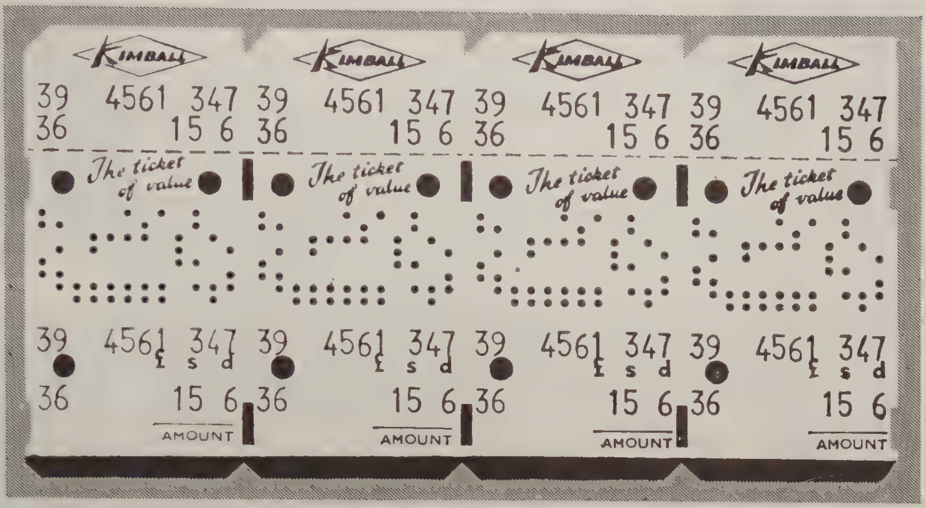
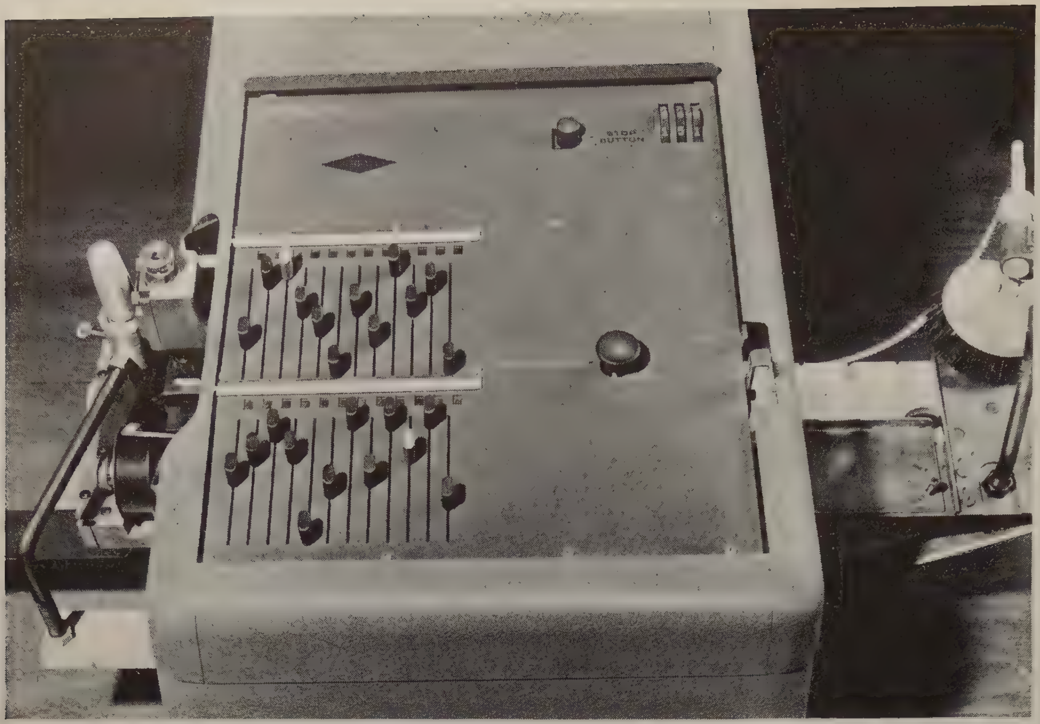
* The construction of decimal binary codes is described in "The universal language of computing," *Data Processing*, January-March, 1959.



A 4-part tag set. Information punched in the tags is repeated in print above and below the main recording area

When the tag is prepared, data punched in it can be repeated in print at both the top and bottom of the tag. The printed data are arranged in two lines across the width of the tag in exactly the same format as the punched data. Each figure is printed in line with the corresponding punched column. This is shown in the accompanying illustration. However, data entered subsequently in the 12 additional columns cannot be recorded in print on the tag. Five special code holes may also be punched level with the lower large-diameter alignment

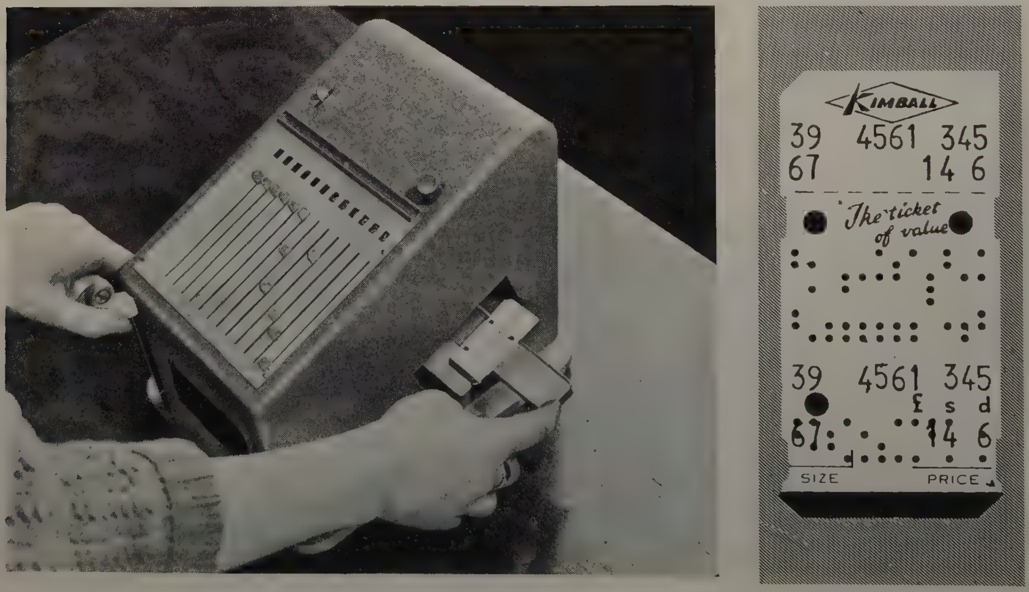
Tags are prepared at the rate of 10,000 an hour by the Kimball 75 punch printer



Control panel of the Kimball 75 punch printer

hole. These holes indicate the function of the tag, such as a stock control tag, price tag or sales tag. Identification holes are punched where there is a chance that a tag could be used in the wrong data processing procedure. For instance, if a 4-part tag set is used and a tag has to be removed at a specific stage during a sequence, there is always the possibility that two tags may be removed in error. Then, should an attempt be made to pass two tags from the same set through the reader, the duplicated one will be rejected as it will contain the wrong identification hole. Thus the machine guards against an operator making a mistake.

Up to 12 digits of additional data may be recorded in the lower portion of a tag using a station punch

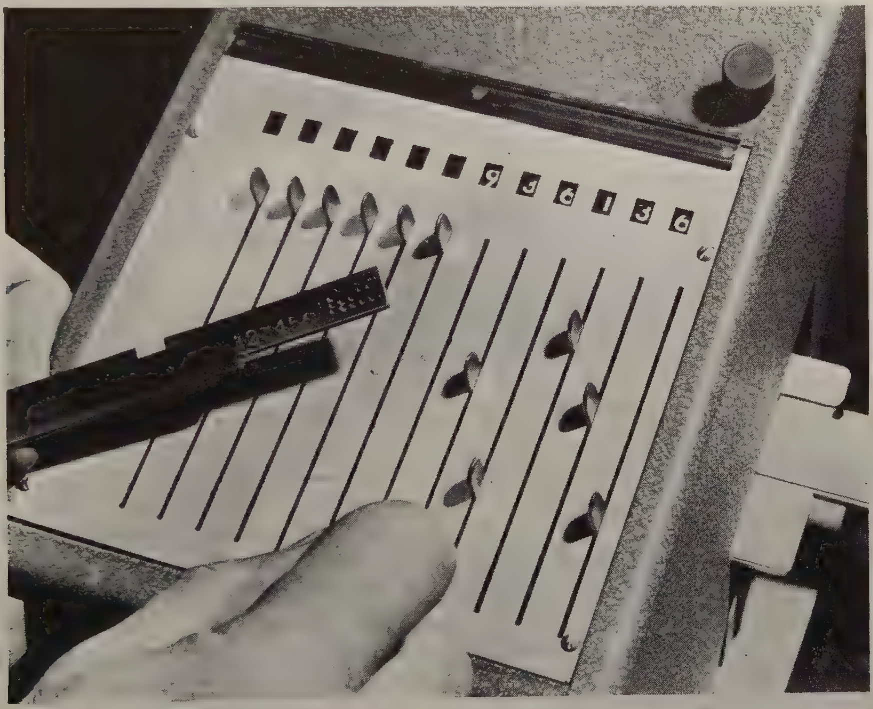


In addition to the data punched and printed on the tag, other information may be displayed. The name and address of the firm and sales slogans can all be pre-printed on the tags.

Tags are prepared automatically at the rate of 10,000 an hour by the Kimball 75 punch printer—probably the fastest ticket printing device in the world. Data to be punched and printed are selected by manually setting 24 slides provided on the upper panel of the printer. In the panel, above each slide, is an aperture in which a figure is displayed showing the setting of the particular slide. In this way, information set on the machine can be checked visually before any tickets are prepared. A four-position control knob on the right of the machine is rotated to indicate whether 1-, 2-, 3- or 4-part tag sets are to be produced. Finally, the number of tag sets to be punched within the range from 1 to 999 is selected on three knurled control wheels.

When the "start" button is pressed, a continuous strip of pre-printed tags is fed into the punch printer from the right and punched tags emerge on the left. As the continuous strip of tags emerges, it is guillotined into sets containing the correct number of tags and, when the required quantity has been produced, the machine stops.

Provision is made on the punch printer for the overprinting of a word or short phrase, such as "all nylon," on each tag as it passes through. A slug of type (containing up to four lines of type of 14 characters each) can be placed in the machine for this purpose. Also, to identify particular varieties of tag, a pen can be fitted which draws a coloured band across each tag as it emerges from the machine. The pen can be changed quickly if a stripe of a different colour is required.



A master data-setting key used with the station punch

When additional data are to be recorded in the 12 columns at the bottom of the tag, a manually operated auxiliary punch called a station punch is used. This is similar in general design to the automatic punch and numerical data are set in the same way by pulling down slides. After placing the tag on three pins fitted to a location plate that projects from the right-hand side of the punch, the operator pushes the plate into the punch and depresses a lever on the left-hand side. This action causes the data set on the 12 slides to be punched into the tag. No provision is made for printing these additional data on the tag and only one tag can be punched at a time.

Where data entered by a station punch are repeated regularly, the punch operator can be provided with a master data-setting key. As many as 11 of the 12 figures available can be set up automatically by inserting this key into the station punch. Those figures not set by the master key are selected manually in the usual way. Not only does this save time, but also the keys ensure that the additional information punched in a tag is accurate. A typical application would be in a shop where every sales assistant is given a master key specifying her departmental code number.

In retail sales work the punching of additional data into a Kimball tag is such a valuable procedure that the Svenska Dataregister AB has developed a cash register equipped for this purpose. The Svenska Dataregister, or Sweda cash register, as it is more commonly called, has already been described fully in *Data Processing*†. In contrast with the station punch, the Sweda cash register punch records 24 columns, or digits, of additional data in a Kimball tag. After the tag is removed from the item it is placed in a slot in the cash register and the amount paid, together with any other data, such as the assistant's departmental number, is entered on the keyboard in the usual manner. When the cash register is operated, these data are punched in the tag. Up to 16 digits set on the cash register keyboard can be entered by this method. The remaining eight digits are manually set on slides. These are situated on the extreme left-hand side of the cash register immediately above the slot in which the Kimball tag is placed.

On the left of this Sweda cash register is a punch unit that records sales data in Kimball tags

Data transcription

The automatic transcription of data from Kimball tags into punched cards is accomplished by connecting a Kimball tag reader to a standard gang punch. Any type of electrically operated gang punch, whether IBM, I.C.T. or De La Rue Bull, can be operated, it merely being a question of making the appropriate electrical connections. However, at present, the Kimball reader has been designed to operate with standard 80-column card punches. A new machine—a tag-to-card converter for 40-column I.C.T. cards—is being developed.

Another type of data transcription system can be constructed by connecting a Kimball tag reader to a paper tape punch. With the appropriate code translation unit fitted between the reader and the punch, data can be transcribed into any of the standard 5-, 6-, 7- or 8-channel tape codes.

The Kimball tag reader operates in the following manner. Tags to be read are first threaded on two spindles that pass through two of the large alignment holes. Then the complete stack of tags is placed in the input magazine of the reading machine. From here, the tags are fed automatically, one at a time, to the data sensing station, where a group of wires is brought down into contact with each tag. Wherever holes occur, the wires coinciding with these positions pass through the tag and electrical contacts are closed, energizing a number of relays. These, in their turn, control the operation of the gang punch and cause the

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† See "Recording data at the point of sale," *Data Processing*, January-March, 1960.

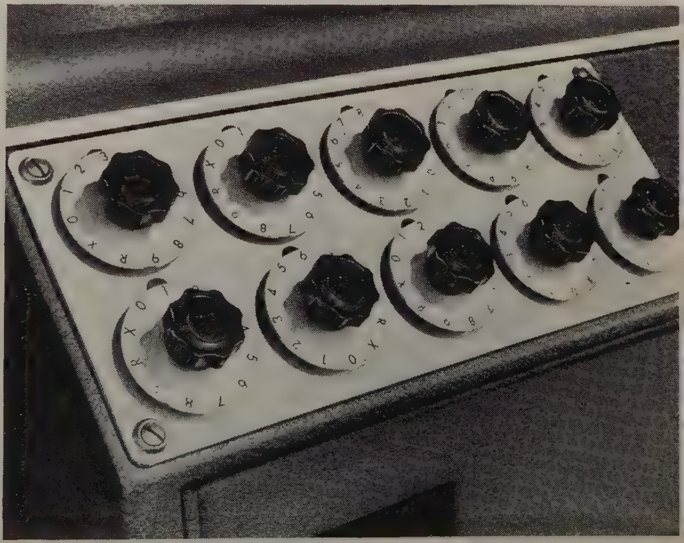
Data are read from Kimball tags and transcribed automatically into 80*-column punched cards by a reader gang-punch assembly*

data read from the tag to be perforated in the selected columns of the punched card. When the reader is connected to an I.C.T. or an IBM 80-column punch, tags are read and cards are punched at the rate of 100 a minute.

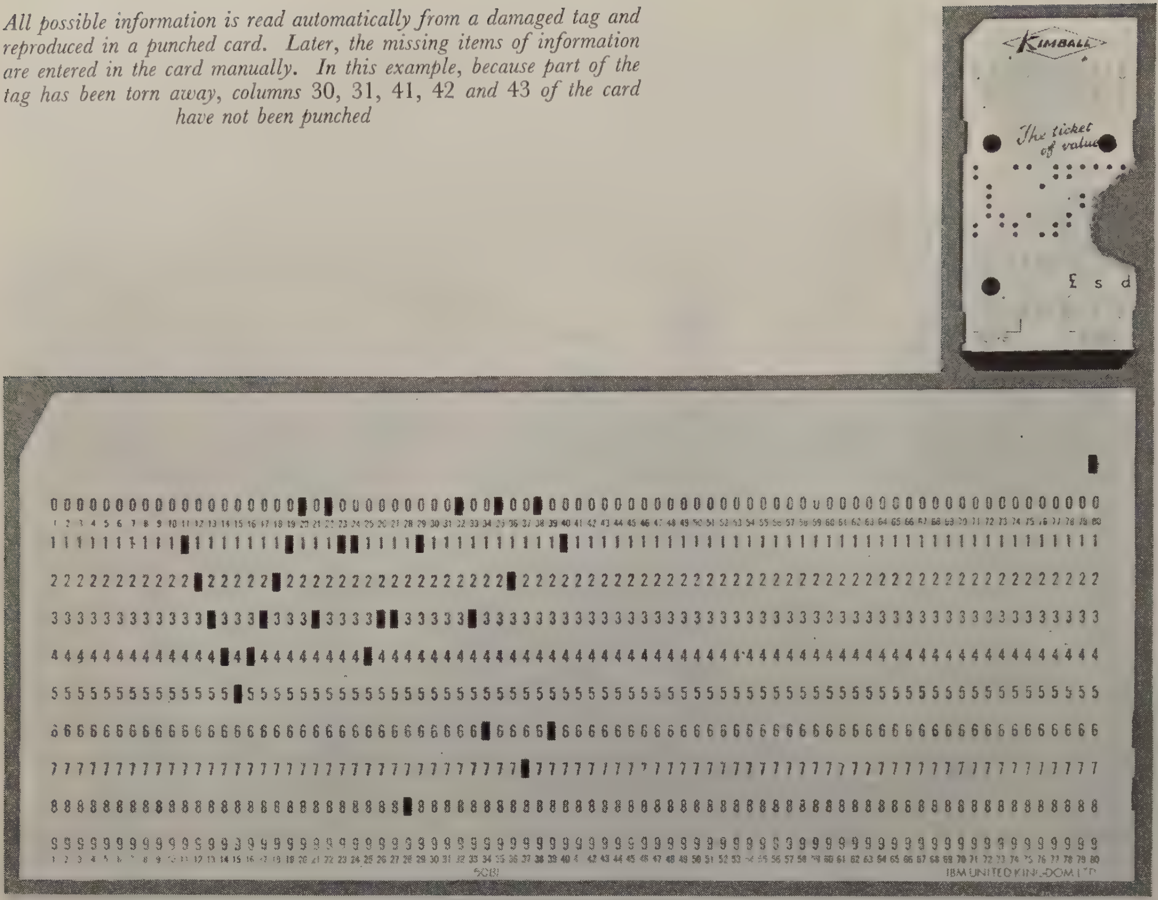
Other information, additional to that read from the tags, can be recorded in the cards. For this purpose the reader is fitted with ten dials which can be set by hand. Fixed information such as the date, a reference number or other coded information, up to a maximum of ten digits, can be entered on these dials.

Yet another way of recording additional data in punched cards is by introducing a master tag with each batch of detail tags. The master tag is sent through the reader first and is identified by a special code hole punched in it. Data read from the master tag are entered into the storage

Additional data to be recorded in punched cards may be set on 10 *dials provided on the control panel of the tag reader*



All possible information is read automatically from a damaged tag and reproduced in a punched card. Later, the missing items of information are entered in the card manually. In this example, because part of the tag has been torn away, columns 30, 31, 41, 42 and 43 of the card have not been punched



registers of the gang punch and are reproduced in every punched card that passes through. This continues until new data are read from the next master tag to pass through the reader. Up to 20 digits of information may be recorded in each master tag.

Fixed data

The ability to read fixed data from a master tag is a valuable feature of the system, because it enables data common to a batch of detail tags to be reproduced in punched cards without encroaching upon the information-recording capacity of the tags themselves.

The maximum amount of information that can be obtained from a Kimball tag reader and punched into a card in one operation is therefore 66 digits—36 digits from the tag, 10 digits from the manually set dials on the reader and 20 digits from a master tag.

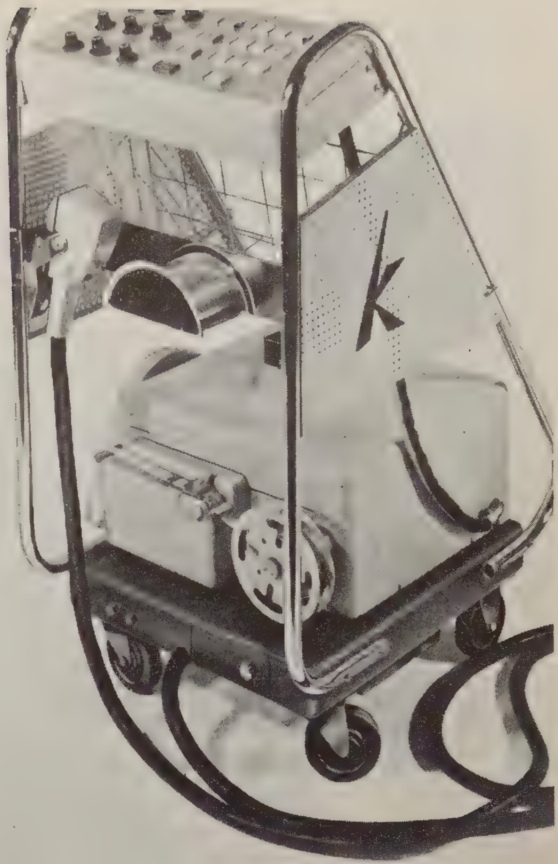
Because the area used for recording punched data is small, tags can suffer quite severe mutilation before they become unreadable. Even where part of a tag is torn away (see accompanying illustration) the reader senses all data that can possibly be read from the tag and punches this information into the card. At the same time an error hole is punched and the reader stops to allow the operator to remove the damaged tag. At the end of the data transcription run, all punched cards containing error holes are sorted out of the pack and the missing items of data are then punched manually in the incomplete cards. This is a perfectly feasible procedure because, although part of the tag may be missing, the same data are repeated in print on the tag at least once, and sometimes twice; consequently, the chance of these data being completely lost or obliterated by the mutilation is remote. The reader rejects a tag as damaged whenever more than two holes or no holes at all are detected in any of the columns. For this reason the figure 0 is always recorded by punching two holes in the two lowest positions of a column.

It has been estimated that a Kimball tag reader connected to a gang punch can perform the work of up to 30 girls.

All the machines described are simple in design and maintenance is relatively easy. The idea of the Kimball tag was born about ten years ago and, as already stated, the tags were designed to overcome the particular problems of the retail trade, although, naturally, they have proved suitable in many other directions.

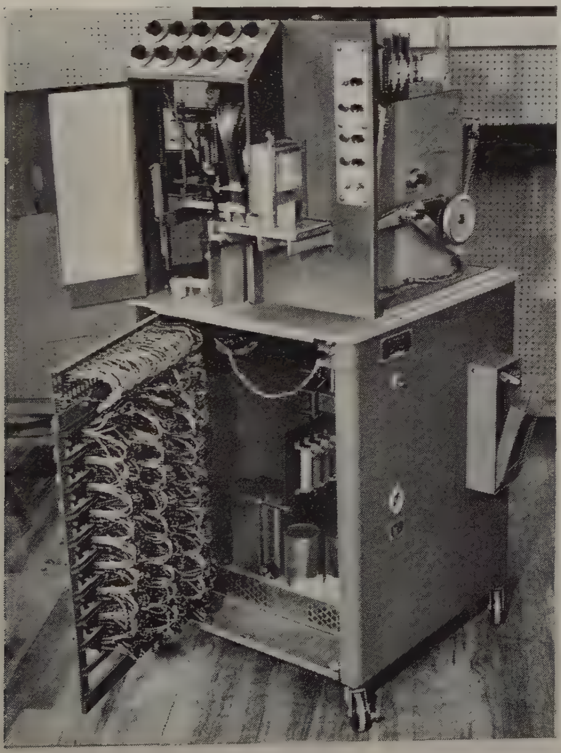
Production

Installations have been running in the United States and in other parts of the world for over eight years. B.U. Supplies and Machinery Company Limited, of Leicester, market Kimball equipment in Great Britain. At present the machines are imported from the United States, but it is expected that within a year or two production will start in Britain.



Mobile tag reader. Data are punched in paper tape

Construction of the Kimball tag reader



Stocktaking using the mobile tag reader

The National Cash Register Company has developed a cash register reading recorder. Data entered on the keyboard are recorded in punched paper tape together with additional information read from a Kimball tag

To show how the various machines of the Kimball system are used, a simple example of a retail sales application will be described. Tags are prepared in two-part sets by the Model 75 punch printer and are attached to the goods. As the two tags in a set contain identical data, a different identification hole is punched in each to distinguish one from the other. Before the goods are despatched from the warehouse to the retail shops, one of the tags is removed. Data read from these tags are transcribed into punched cards by a reader gang-punch assembly. Printed invoices and despatch lists for stock control purposes are prepared from these cards. When the goods arrive at the shops, the remaining tag on each item acts as a price ticket. Every time an article is sold, the tag is removed, leaving behind a printed stub for identification purposes. At this stage in the procedure a station punch may be used to record, in the tag, additional data about the conditions of the sale.

Once again the reader gang-punch assembly is used to transcribe the data from the tags into punched cards. Tabulations produced from these cards indicate which items have to be re-ordered and supplied to the various shops, the gross value of sales made by each shop, sales made by each assistant and each department, and other statistics of interest to management.

In those cases where varying quantities of goods are sold, such as yards of cloth, Kimball tags, pre-punched with the basic identifying data, can be held in a container nearby and whenever a sale is made, the quantity bought is recorded by a station punch in one of the tags removed from the container. This tag, containing all the relevant information, is then returned to the accounting section for processing.

Sales reports

Because, with the Kimball system, data about sales can be obtained and converted into punched cards so rapidly, it is possible for the sales manager to have on his desk at 9 a.m. each morning, a comprehensive report of all sales made in the store up to closing time the previous day. This is actually done by many retail organizations.

Development of the Kimball system continues and a new machine undergoing trials in the United States is a portable tag reading machine. This machine makes stocktaking easier. It is wheeled about the storeroom and tags still attached to the products are read by a hand-held sensing device. The data are punched in paper tape which can then be fed into a computer or transcribed into punched cards by a tape-to-card converter.

Cash register reading recorder

Another interesting machine, developed independently by the National Cash Register Company, is a new type of cash register that incorporates a Kimball tag reading unit. Before a sale is recorded, the tag is placed in the reader of the cash register and other data, such as price paid, are entered on the keyboard in the usual way. When the register is operated, data read from the tag are punched in paper tape together with the data entered on the keyboard. Thus in one operation all the facts about the product and the conditions of the sale are transcribed into punched paper tape.

Furthermore, there is no reason why, if required, a Kimball tag reader should not be connected to a computer to provide input data. At present, Kimball tags are used for such diverse jobs as sales analysis, stock control, production control, cash control of sales, price tags, travel tickets and hire-purchase repayment tickets. The two biggest installations in Great Britain are those in which Kimball tags are used as price tickets.

Undoubtedly, the great advantage of the Kimball system is that it eliminates all manual data transcription and verification procedures together with the errors that are always associated with such methods.

Paper tape punch fitted to the cash register reading recorder. The data punched in the tape can be transcribed into punched cards or fed directly to a computer

Collectadata

A new data transmission system by which information from the various departments of a business or factory is fed to a central data processing station via a landline

Paper tape or edge-punched card reader transmitter

- **In an example described, the system is used to record the movement of production orders through a factory**
- **All data received before midnight are processed by the time the dayshift starts in the morning**
- **Costs are estimated to be reduced by 70 per cent**
- **Stock control, sales control, invoicing and production time recording are among the applications**
- **Unskilled personnel can operate the equipment**
- **Handwritten reports are no longer required; paperwork circulating in the factory is greatly reduced**

ELECTRONIC digital computers process data rapidly, but until comparatively recently little had been done to improve the speed of gathering and transmitting basic data to the computer. Now Friden—the company that manufacture the Flexowriter*—have introduced Collectadata.

Essentially, a Collectadata system comprises a number of data transmitters connected by a single landline to a data receiver. The receiver punches the data into 8-channel paper tape, which can then be fed directly to the tape reader of a computer or to some other data processing machine.

There are three different types of transmitter. One reads data from 8-channel punched tape or 8-channel edge-punched cards, the second reads standard 80-column punched cards, while the third is an adaptation of the punched-tape transmitter and reads 8-channel punched data recorded along the edge of a wide document such as a large index card. Cards of this last design are sometimes referred to as form cards

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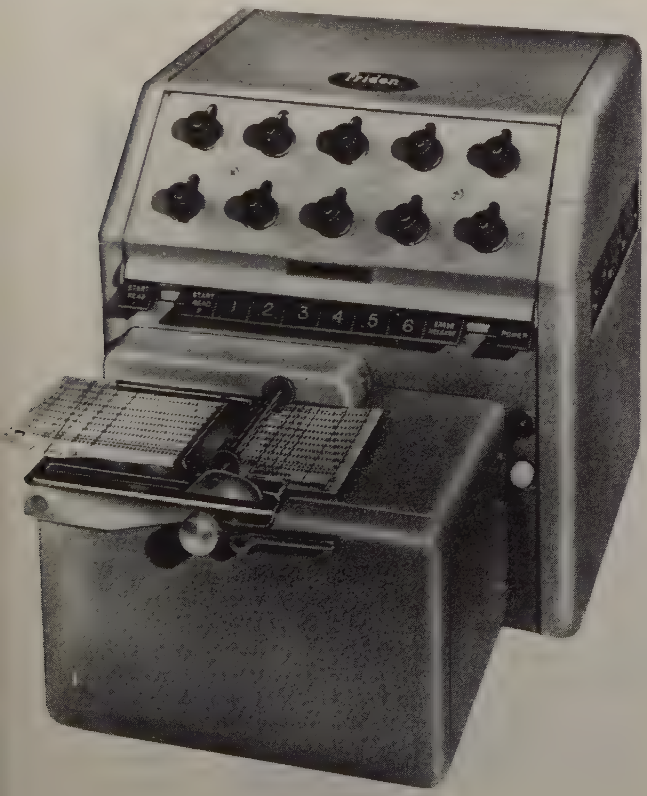
*The Flexowriter is a punched-tape-operated electric typewriter. A description of this machine and how it functions has been given in "Accurate copy typing at 100 words a minute," *Data Processing*, October-December, 1959. Friden machines and systems are marketed in Great Britain by Bulmers (Calculators) Limited.

and are made from plastic or reinforced paper. In effect, a form card is a larger version of the conventional edge-punched card.

A prototype Collectadata system was installed in the Convair aircraft factory in 1956. It is used to record the movement of production orders through the workshops. A number of data transmitters are located at strategic points throughout the works, which cover 20 acres, and information is fed back from them to a central data processing department. All data received before midnight are entered into a computer which performs the necessary calculations and prints production reports in time for the beginning of the dayshift at 7 a.m.

This collection and channelling of information from many widely separated points within a factory to a data processing centre is a typical application for a Collectadata system. In fact, the majority of the systems at present installed or on order are for aircraft companies in the United States of America which will use them for similar manufacturing control purposes. Recently the Norair Division of the Northrop Corporation placed an order worth more than £85,000 for a system which it is estimated will reduce the costs of collecting and transmitting data from the production departments by approximately 70 per cent.

A Collectadata transmitter that reads information from standard 80*-column punched cards*



One of the big problems, if not the biggest problem, with any method of acquiring basic information is to ensure that it is accurate. This is largely overcome with the Collectadata system because much of the information to be transmitted can be pre-punched in tape or cards. For example, the document providing the authority to manufacture a certain number of parts can be a standard 80-column punched card. In this card are punched the order number, part number, description and quantity to be manufactured, together with all other pertinent fixed data. Every time these data have to be relayed from the factory to the data processing centre the card is placed in a transmitter, thus ensuring that the main reference data conveyed are always accurate. At the same time other information can be entered manually at the transmitter and relayed back.

Two important advantages obtained with this method of data transmission are that shop personnel no longer have to complete hand-written records and the volume of paperwork circulating in the factory is greatly reduced. Another important advantage is that the work of the data processing centre is also reduced, because many manual data transcription operations are eliminated.

It has already been mentioned that there are three types of transmitter. All are basically similar in design except for the reading units. Those which read the 8-channel codes punched in tape or cards are also fitted to standard Flexowriters and consequently are fully developed items of equipment. In the case of punched cards a special reading unit was designed.

In addition to the fixed data read from the punched tape or cards, up to 19 extra digits of information can be relayed back from a transmitter. Two banks of manually operated control dials and a group of six switches are provided for this purpose.

Ten rotary switches fitted in a panel at the top of the transmitter comprise a group known as dial bank B. Each of these switches can be set at any one of 12 positions—ten positions for the decimal values 0 to 9 and the remaining two for a space and a blank. A further eight rotary switches—dial bank A—divided into two groups of four, are situated on the sides of the transmitter. Usually semi-permanent data are set on bank A and, to reduce the risk of these dials being altered accidentally, a screwdriver is needed to set them. Data entered on bank A might be a number identifying the transmitter, or the department in which it is located, or even the day's date.

Alternatively, if a considerable quantity of variable information has to be entered at a particular transmitter, all 18 dials, fitted with hand control knobs, can be arranged on one panel.

Control switches

Finally, six switches are arranged in a line along the front of each transmitter. One of these may be depressed to identify the type of information being transmitted or the purpose for which it is being sent. Two signal lights and a number of control switches are also provided.

The Collectadata receiver has an 8-channel paper tape punch. This unit also is basically the same as that fitted to a standard Flexowriter. In addition to a tape spool holding 1,000 feet of paper tape, the receiver is equipped with two control switches, a signal light and a connection for a time clock. Data are punched in tape at the rate of 14 to 15 rows a second and the spool holds sufficient for over 130 minutes' continuous operation.

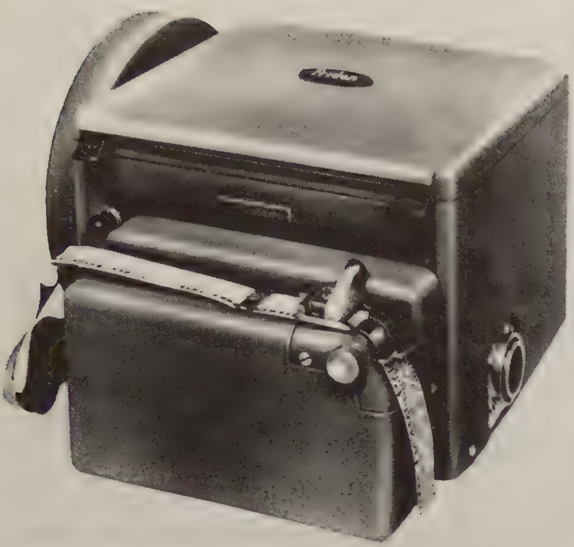
A parity check is performed on all data recorded by the punch to confirm the accuracy of the information received. The rule laid down is that each row of tape must contain an odd number of holes. An even number of holes indicates an error and, should this condition occur, a red signal light on the receiver is switched on and an error code is punched in the tape. An error light at the transmitter is also switched on. Transmission does not stop, but as soon as the end of the message is reached the operator at the transmitter presses an "error release" key and relays the data again.

The red error light on the receiver is also illuminated if the tape tension increases above a prescribed limit or if the tape spool is empty

A time clock, or more precisely a time code emitter, can be connected by cable to the receiver. This supplies a five-digit number which is punched into the tape on every occasion a code, known as the "stop 2" code, indicating the end of a message, is received from a transmitter. Time is recorded in one-hundredth-of-an-hour units and a five-figure counter on the clock shows the time that has elapsed since it was last set to zero. The clock need only be reset once a month.

Any number of data transmitters may be connected to one receiver. If the quantity of information to be handled necessitates the use of more than one receiver, the transmitters are arranged in groups and each group is connected

Additional data for transmission are set on manually operated dials. Eighteen dials are provided on the control panel of this transmitter



The receiver records data in 8-channel paper tape at the rate of 14 to 15 characters a second

A clock may be connected to the receiver for signalling the times of transmissions

to its own receiver. All the units of a system are connected together by a single multi-core cable containing 14 or more wires. The actual number of wires depends upon the size of the installation. Data are transmitted in parallel and, as an 8-bit code is used, eight wires are required for this purpose alone. The remaining six or more wires carry control signals. Provided the capacity of the cable permits, extra units can be added to a Collectadata system at any time.

Because all the transmitters and receivers are connected together by a single landline, only one unit at a time can transmit information. A white signal light is fitted to each transmitter and this is illuminated if an attempt is made to relay a message when the line is already engaged.

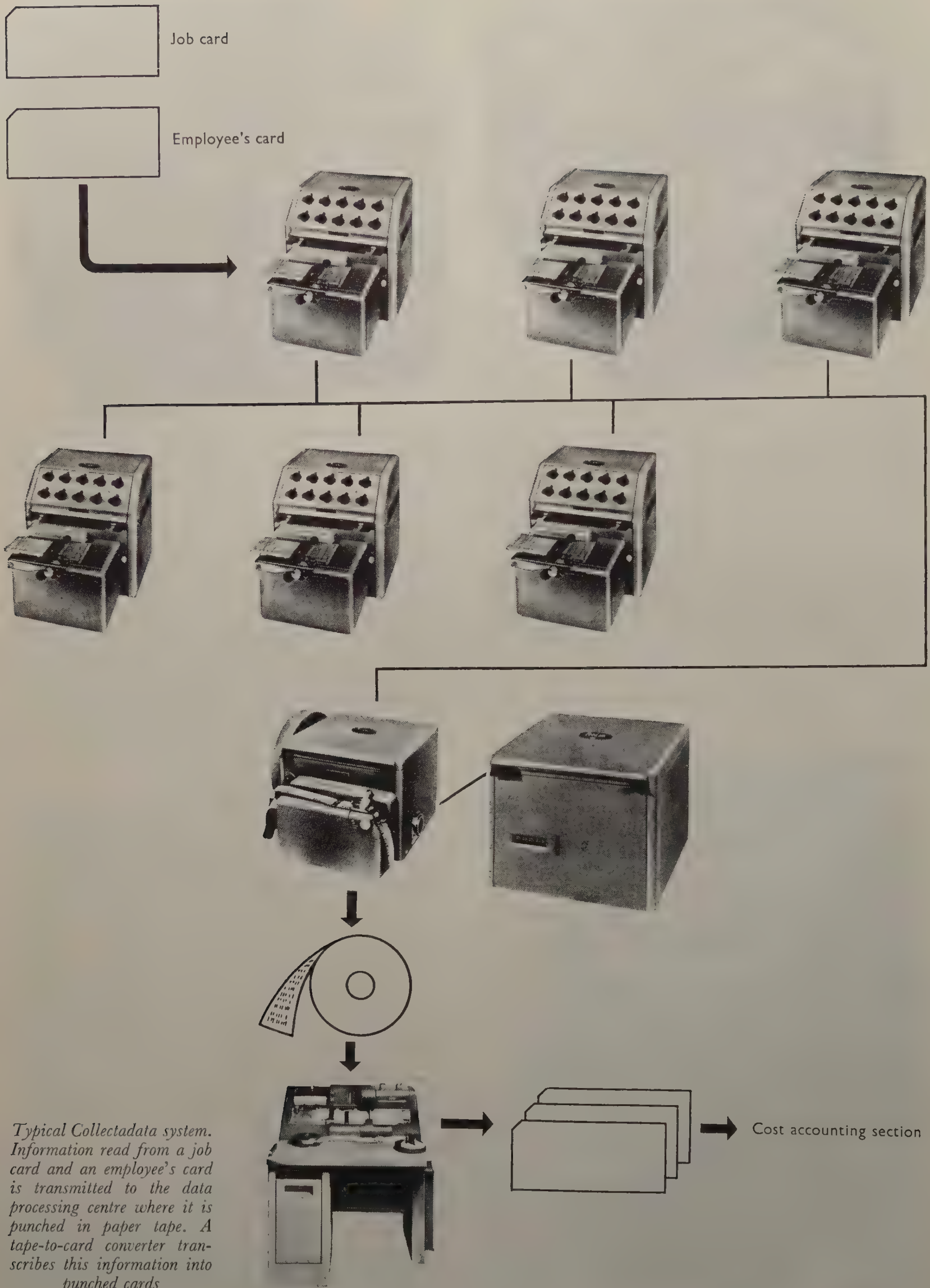
Messages are relayed from transmitters on a first-come, first-served basis. If the line is free, the first transmitter to be switched on captures the line. The next transmitter switched on has to wait, but begins to transmit data as soon as the first machine relinquishes the line. Any other transmitters switched on during this time, however, are not taken on a first-come, first-served basis, but are switched on in a sequence that is determined by the operation of the scanning switches of the system.

To transmit data the following procedure is adopted:— First, the transmitter power switch is depressed; next, the card or tape is fed into the reader; then a switch labelled "start read 1" is pressed. Immediately transmission begins. The first item of data read from the punched document must be a "start read 1" code. If this is not detected, transmission stops immediately to indicate that the incorrect document has been placed in the machine or it has been fed in the wrong way round. Whatever the reason, the line is relinquished and the operator has to correct the fault and start again.

Data transmission sequence

If the "start read 1" code is read correctly, it is transmitted and is the first item to be punched into the 8-channel tape by the receiver. After this the next data to be relayed are those set on dial bank A of the transmitter. Following this, a single digit is transmitted indicating which one of the six identification switches is down. Then data are read from the punched document until a special transfer code is detected when the data set on dial bank B are relayed. Data from dial bank B can be sent at any time during a transmission. Finally, at the end of the message, a "stop 2" code is read. This switches off the transmitter and releases the line for use by another transmitter.

The "stop 2" code itself is not transmitted and consequently is not punched in the tape; instead a pulse is sent along one of the control wires to the receiver. If a time clock is connected to the receiver, this pulse causes the current time code to be punched in the tape.



Typical Collectadata system. Information read from a job card and an employee's card is transmitted to the data processing centre where it is punched in paper tape. A tape-to-card converter transcribes this information into punched cards

Finally, if no parity error has been detected, an "end-of-message" code is punched in the tape; if an error has been signalled, an "error" code is punched instead.

Sometimes it is necessary to transmit data from two or more cards in sequence. To prevent the transmitter from losing the line when the first card has been read, the following procedure is used. The first card is transmitted in the manner already described except that a "stop 1" code, instead of the "stop 2" code, is punched as the final item in the card. The "stop 1" code suspends transmission, but enables the transmitter to retain the line. When the second card is fed into the reader, a "start read 2" key is pressed and transmission continues.

No time or end-of-message code is punched in the tape following receipt of the "stop 1" code. Also, the first code read from the second card must be a "start read 2" code: otherwise, as before, transmission stops, but in this case the line is not relinquished. Control of the line is retained to enable the operator to rectify the mistake. Finally, a "stop 2" code will appear as the last item on the second card and the time and end-of-message codes will be punched in the tape as usual.

If data on more than two cards are to be transmitted, a "stop 2" code is punched in the final card and "stop 1" codes in all the others.

Only 8-channel tape is punched and, as most modern computers and data processing systems use either 5- or 6-bit codes, this leaves ample capacity for future developments.

Applications

Manufacturing control is the principal application for which this data transmission equipment is being used at present. However, there are many other situations in which it could be employed—stock control, sales control, and invoicing, to mention a few.

Another application, allied to manufacturing control, in which good use could be made of the facilities offered by the Collectadata system is production time recording. Many companies use punched cards as works documents and, for these firms, a production time recording system might be organized in the following way.

A punched card—in effect the job card—travels with each batch of parts as it passes through the factory. Each employee in, say, the machine shop is also provided with a punched card on which is entered his number, the machine number and the machine rate. When work is to be started on a batch of parts, data are read in sequence by the transmitter from first the job card and then the operator's card. These data are transmitted as a single message to the data processing centre. Similarly when the job is completed these data are transmitted once again. A time clock connected to the data receiver records the job starting and finishing times in the tape.

Data punched in 8-channel tape are transcribed into punched cards at the rate of 20 characters a second by this IBM tape-to-card converter

These data can then be fed directly to a computer or transcribed on to punched cards by passing the tape through a tape-to-card transcription unit. Whichever method is adopted, the basic information for cost accounting is obtained rapidly and accurately with the minimum of human intervention.

Because this data transmission system requires a multi-core landline, it cannot be connected to outside telegraph or telephone lines. But as an internal and private method of transmitting information throughout a factory or a large commercial organization it possesses many advantages, not the least of which are that it can be operated by untrained personnel, the volume of paperwork circulating is reduced, fewer clerical staff are needed and many manual data transcription and verification operations are avoided.

Automatic banking

A range of machines has been developed by the Burroughs Corporation to operate with the code, printed in magnetic ink, that has been accepted by the American Bankers Association as the common machine language for cheques and deposit slips. This code consists of the ten decimal figures 0 to 9 and four control signs. These symbols can be read by both men and machines.

A new computer—the Visible Record Computer—has also been introduced by Burroughs. It is specifically designed for banking work and is of unique design in that it reads data printed in magnetic ink on cheques, performs the necessary computations and prints the results directly on the bank documents in normal everyday use.

While produced primarily for banking, the new equipment can obviously be used for administering accounts of many different types

ALREADY, in a year, more than 800 million cheques are used in Great Britain alone. This figure gives some idea of the extreme pressure being exerted upon the existing bank services. And with countries growing richer and world trade expanding, the volume of work is building up so rapidly that now a point has been reached where a new development in the mechanization of banking operations is imperative. However, although the problem is clearly seen, the methods to be adopted for its solution are by no means so obvious.

One of the more immediate difficulties is, of course, concerned with the handling of cheques. At the moment, all the data recorded on a cheque are read and transcribed manually. A prodigious number of clerical hours is absorbed each year on this unrewarding work, but recently several machine systems have been developed that can read information printed in magnetic ink on a cheque and process it automatically. Obviously before such systems can be adopted by the banks, agreement has to be reached on the printed code to be used in order that the many different banking organizations within a country may be able to handle each other's cheques.

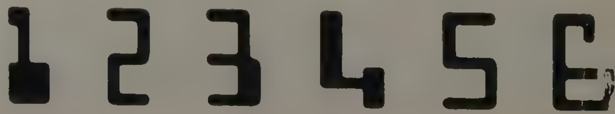
In the United States of America, the American Bankers Association have agreed on a common language code that can be read by both men and machines. It is known as the E-13B code and consists of 14 symbols printed in magnetic ink. Ten of these symbols are the numerals 0 to 9, the remaining four being control signs. This code is illustrated on the right.

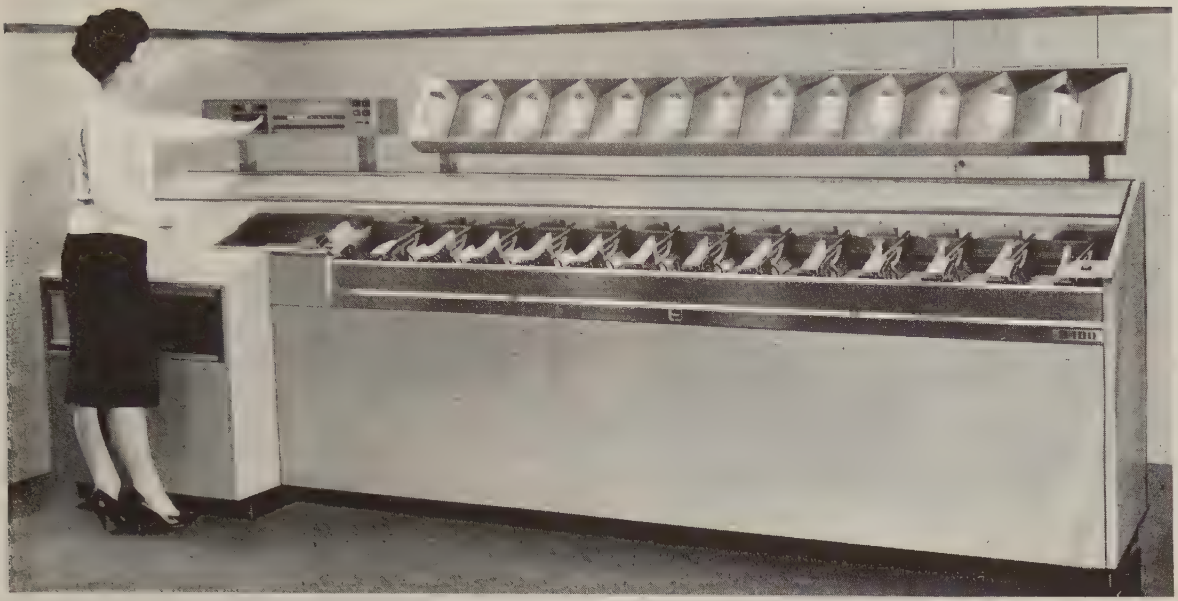
At the moment neither the British banks nor the European banks have decided on a common language code, although the Electronics Sub-committee of the London Clearing Banks is expected to make a recommendation before the end of this year and has enlisted the help of the National Physical Laboratory for this purpose. Of course, a bank could adopt its own code, but the advantages gained would be limited.

In 1956, all the principal banks, printers and accounting machine manufacturers in the U.S.A. agreed with a recommendation that a magnetic ink character code should be designed for banking work. The Companies interested then co-operated in the development of the E-13B code and the final design of the symbols was agreed in December, 1958. By March, 1959, Burroughs were able to demonstrate a machine called a sorter-reader. This machine reads data printed in the E-13B code from cheques and other banking documents and sorts them at a speed of 1,560 a minute.

Later, in September of the same year, Burroughs demonstrated a new type of electronic digital computer called the Visible Record Computer. This machine was specifi-

(Below) Enlarged examples of the 14 *printed symbols of the E-*13*B code developed for banking work*



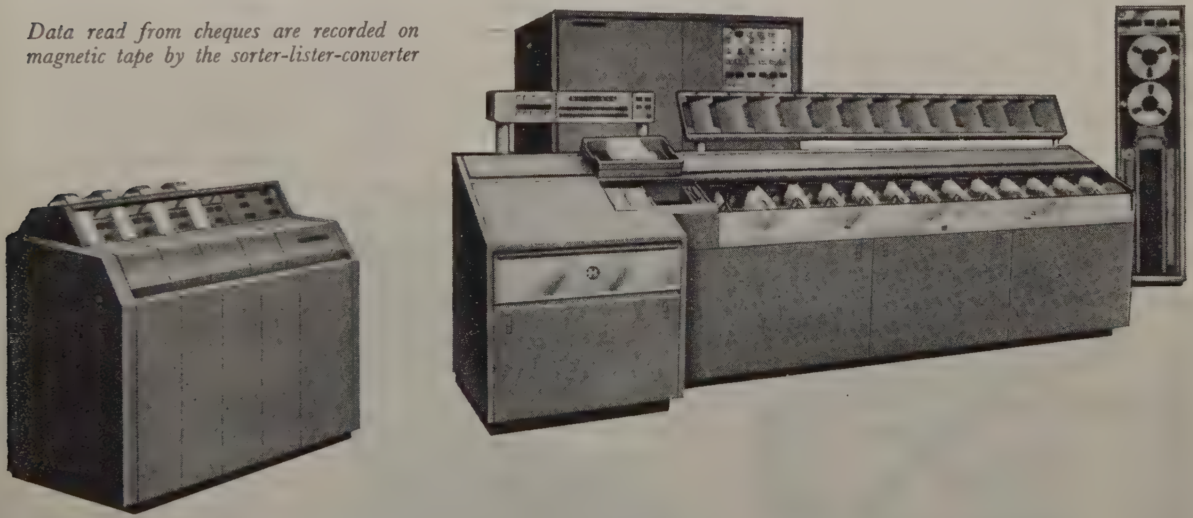


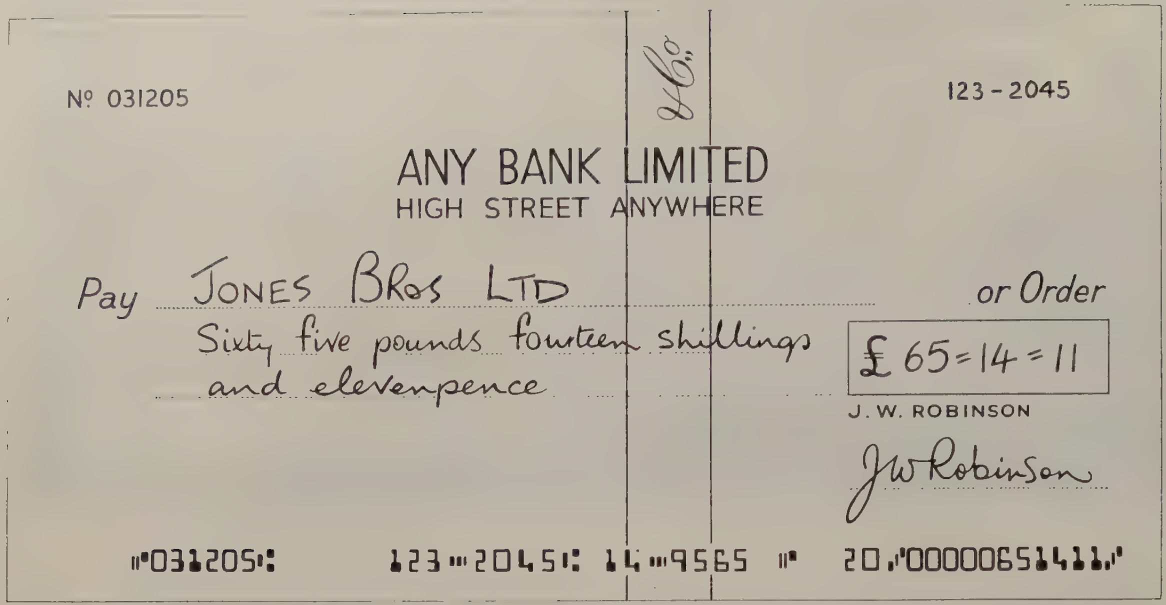
Cheques are sorted at the rate of 1,560 *a minute by the Burroughs sorter-reader*

cally designed for banking work, and one of the data input units provided is the magnetic character sorter-reader. It is connected by cable to the computer and transaction data read directly from bank documents, such as cheques and deposit slips, are used to up-date the customers' accounts. In a similar manner, entries and new balances are printed directly on to the appropriate account ledger cards and customers' statements. As data are obtained from and printed upon the actual banking documents in everyday use, no intermediate data transcription operations are necessary.

Besides being connected to a computer, the sorter-reader can be operated in conjunction with other data processing machines. One of these is a sorter-lister-converter. As cheques are sorted, the data read from them are transcribed on to magnetic tape. Simultaneously the same data are printed by an electrostatic method on

Data read from cheques are recorded on magnetic tape by the sorter-lister-converter





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The magnetic characters of the E-13B code are printed in one line across the bottom of a cheque

to other documents. The magnetic tapes produced by the sorter-lister-converter can then be used on general-purpose computers such as the Burroughs Models 205 and 220 machines.*

Several other machines which operate with magnetic ink characters are also manufactured by Burroughs, including a cheque imprinter, an amount and account number printer and a bank proof machine. From this range of machines of varying complexity and ability, many different types of data processing systems can be built. The final choice will depend primarily upon the volume of work to be handled, the time in which it has to be performed and the way the system is to be extended to cope with additional work as business expands.

The first job with this method of data processing is, of course, to print on the documents all the pertinent information in magnetic ink characters. With the American system the magnetic characters are printed in one straight line across the width of the cheque, $\frac{1}{4}$ inch above the lower edge. This code line is divided into sections in each of which specific information is printed. The arrangement of this information is, again, one of the subjects on which all banks have to agree before mechanized cheque handling can be introduced.

Three items of data are printed in magnetic ink on the cheques before the banks receive them. These are the cheque serial number, the bank code number and the branch number.

Before the cheques are issued by the branch bank, the customer's name and account number also have to be printed on each cheque in magnetic ink. A Burroughs cheque imprinting machine can be used for this purpose. Cheques and deposit slips are printed or "personalized" by this machine at the rate of from 60 to 90 a

At the branch bank, customers' names and account numbers are printed on cheques and deposit slips by an imprinter minute depending upon the size of the forms used by the particular bank. Although the customer's name is not used in the data processing sequence—only the account number—the name is printed on all cheques to prevent them being issued to or used inadvertently by the wrong person.

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* Brief descriptions of these computers were given in "A review of electronic digital computers," *Data Processing*, January-March, 1959.

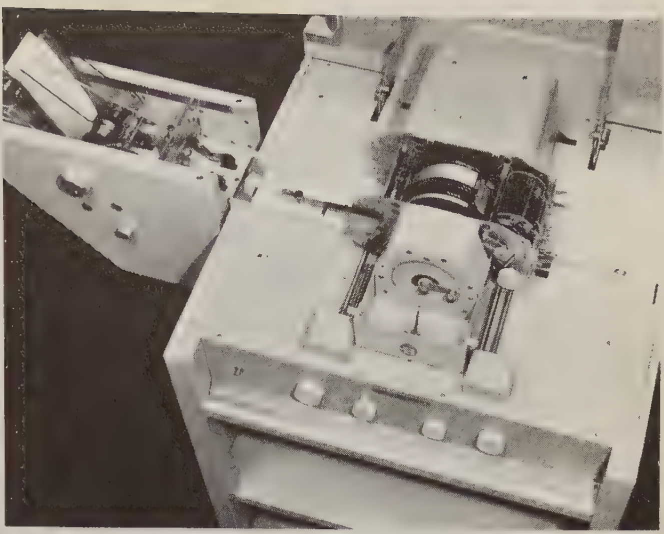
Loose cheques are placed in the hopper of the imprinter. A plate containing the customer's name and account number is fitted to the rotary printing head, a control specifying the number of cheques to be printed (between 12 and 50) is set and the machine is started. When the required number has been printed the machine automatically stops; the personalized cheques are gathered together; stapled into a cover and the book is issued to the customer, who uses them in the normal way.

As inferred, a separate printing plate is kept for each customer. It consists of a flexible slotted plastic frame into which the printing type—the special E-13B type—is fitted and locked in position. These plates are quickly attached or removed from the rotary printing head.

Any standard size of cheque or similar document can be handled by the imprinter; in fact, it can accommodate documents up to 5 inches wide and 19 inches long.

An imprinter with an automatic cheque-feeding attachment costs about £700, and it is envisaged that one will be installed in every large branch bank so that customers can be provided with personalized cheques and deposit slips on demand.

As far as a bank's customers are concerned, the only changes in procedure are: cheques are "personalized" and a deposit slip bearing the individual's account number in magnetic ink has to be completed when cheques are paid in.

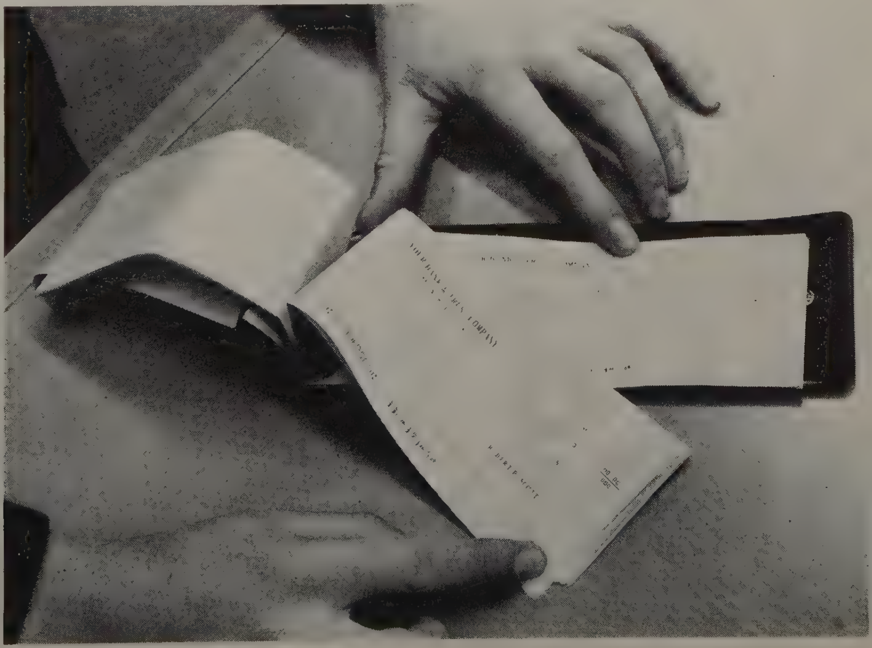


Printing head of the cheque imprinter. Cheques are printed at the rate of 60 *to* 90 *a minute, depending upon size*

Several cheques, of course, may be submitted for payment accompanied by one deposit slip. Whenever a bank issues cheques to a customer, a number of magnetically printed deposit slips are included at the back of the cheque book as shown in the illustration below.

After the cheques are presented for payment, the next task is to imprint on them the amounts for which they are drawn. Once this has been done, the cheques can be handled completely automatically and all subsequent clerical operations can be performed by machines. Ideally, the branch where the cheques are paid in would print the amounts on them. This will, of course, mean that banks will have to print the amounts on each other's cheques. Naturally, during the early stages of introducing a mechanized banking system, many of the branches will not be equipped with the necessary

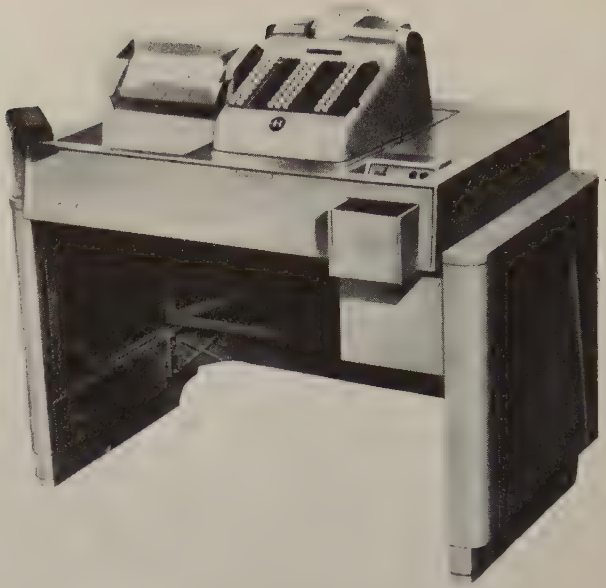
A number of deposit slips, bearing the customer's name and account number in magnetic ink, are included at the back of each cheque book



machines; consequently, it is likely that amount printing will initially be done by the central cheque clearing departments of the banks concerned.

In the Burroughs range of equipment, amounts can be imprinted on cheques by one of two machines. One is the amount and account number printer and the second, and more expensive machine, is the bank proof machine.

In essence, the amount and account number printer is an adding-listing machine equipped with a magnetic character printing unit and two totalling registers. Cheques and deposit slips are stacked on a shelf to the left of the keyboard. The operator reads the value written on the document and enters it upon the amount keys. She also enters, on two columns on the extreme left of the keyboard, a transaction code which indicates whether the amount is a deposit, dividend, bank charge and so on. When all the data have been entered, the operator drops the document in a chute on the left of the machine and then presses one of the motor-bars. Immediately the data on the keyboard are entered in both of the registers and, at the same time, the document is transported from a chute past a unit which prints, in magnetic ink, the amount and transaction code in the correct positions in the code line. Then the document is ejected into a storage tray on the right. Simultaneously a record of the data transcribed is printed on a tally roll.

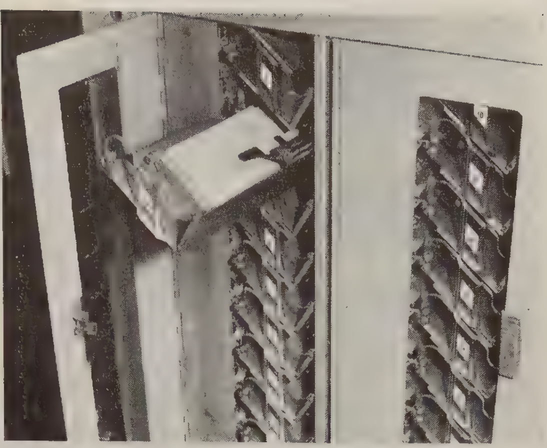


An amount and account number printer

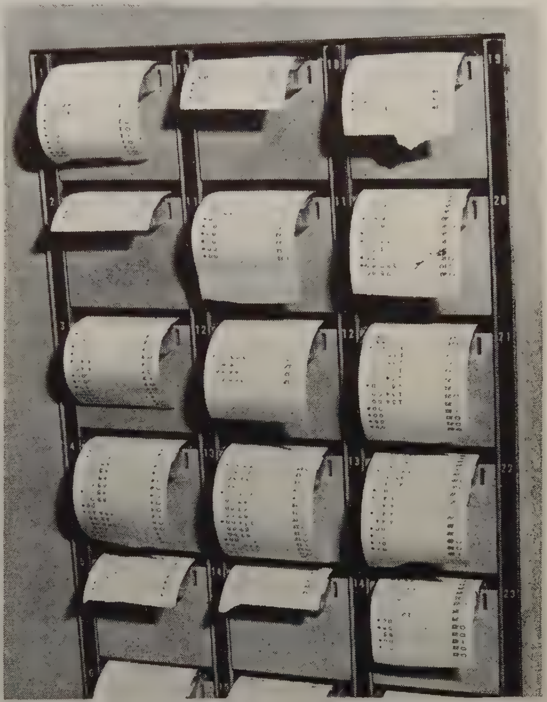
The deposit slip that accompanies each batch of cheques enables the accuracy of the data transcribed to be confirmed. Deposits are entered as credits and cheques as debits. Consequently, when one complete batch of documents has passed through the machine the total in the adding register should be zero. If it is not, an error has been made and the operator must find and correct the figures before passing on to the next batch.

Where an error is discovered, the document bearing the incorrect value is removed from the

The Burroughs bank proof machine can also be used to print magnetic ink characters on cheques



Cheques are sorted into 27 pockets by the bank proof machine



The document printing unit is equipped with a corresponding tally roll printer for each of the 27 pockets

batch and dropped once more into the chute of the machine and an "error" key is depressed. As the document passes through for the second time, an obliteration code is printed next to the incorrect amount. Then a second document is prepared bearing the correct amount and the customer's account number. Afterwards these two documents proceed through the data processing system together. Whenever data are read from the first document, the obliteration signal indicates to the particular machine that the value printed is incorrect and that the true value is recorded on a second document which follows.

Various control switches are provided so that the operation of the amount and account number printer can be altered. For instance, the magnetic ink printing unit can be disconnected and the machine used as a conventional adding-listing machine. Also, provision is made for the customer's account number to be printed on those cheques ~~on~~ which this information is not already recorded—cheques that possibly originate from small branch banks that do not possess an imprinter.

Using this machine, an operator can transcribe amounts on to documents at the rate of between 1,000 and 1,500 an hour.

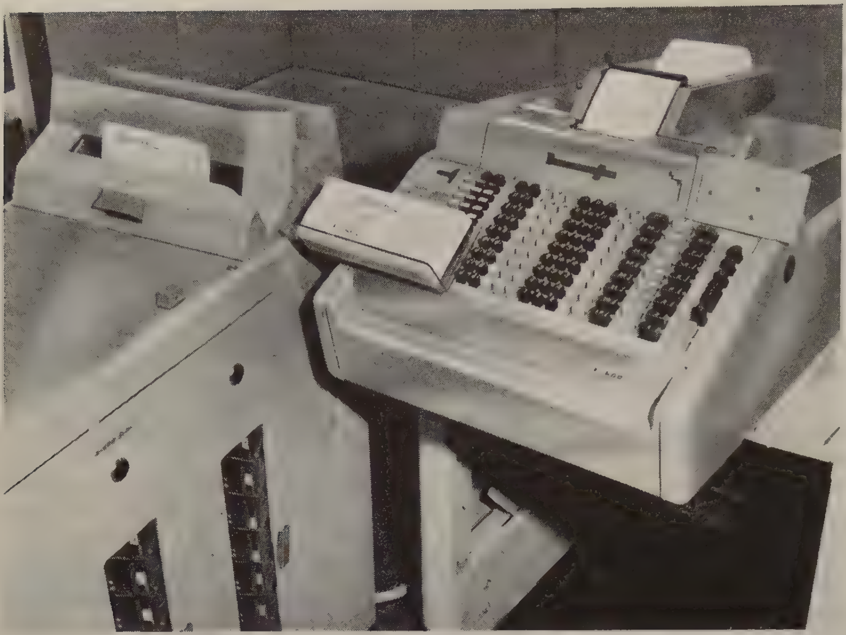
Bank proof machine

The second machine—the bank proof machine—is more versatile than the amount and account number printer. In addition to printing amounts, it sorts documents into 27 groups. It comprises three separate cabinets connected by electric cables. These units are the master unit, the listing unit and the document printing and sorting unit.

The master unit consists of an accounting machine keyboard, a tally roll printer and a control panel. On the panel is a number of programme switches that can be set to vary the mode of operation of the machine.

The printing and sorting unit is provided with a chute in which the documents are placed, one at a time. When the machine is operated, the document is transported automatically from the chute past a unit which prints the data entered on the keyboard together with any endorsements. Then the document is directed into one of the 27 storage pockets.

Last, the listing unit comprises 27 tally roll printers—one for each storage pocket provided in the sorting unit. Each printer records the values of the documents stored in the corresponding pocket. A totalling register also operates in conjunction with each tally roll printer; consequently, at the end of a posting run the total value of the documents stored in each pocket is printed at the end of the appropriate list. Another register is provided in which the grand total of the amounts on all the documents can be compiled.



Keyboard of bank proof machine and, on the left, the chute into which the documents are dropped

For bank work the machine is employed in the following manner. A bundle of deposit slips and cheques is handed to the operator, who reads each one and enters on the keyboard the amount and transaction code. In addition, the operator selects one of a group of classification keys numbered from 1 to 27.

Then the document is dropped in the chute of the sorting unit which is positioned on the left of the master unit within easy reach of the operator. Next, the appropriate motor-bar is pressed.

After the amount and transaction code have been printed in magnetic ink, the document is directed to one of 27 storage pockets according to the particular classification key selected. At the same time the amount and the classification number are printed on two tally rolls—the master tally roll and the appropriate classification tally roll. The master tally roll printer is the one located above the keyboard and on it appears a record of all entries in the sequence in which they were made.

As before, every batch of cheques is accompanied by a deposit slip; and as the data are transcribed on to each document in turn, so the total for the batch is compiled in a master register. Whenever one batch of documents has been dealt with, the final total recorded in the master register should be zero. If this is not so, the keyboard locks to warn the operator that a mistake has been made.

After all the documents have passed through the machine the operator presses an "all total" key. Immediately the totals in each of the 27 classification registers are printed in sequence on the master tally roll. Also, the appropriate total is printed at the bottom of each classification tally roll. Finally, a grand total for all entries is printed at the end of the master roll. This entire operation takes 24 seconds to complete.

Then the operator retrieves each batch of documents from the storage pockets into which they have been sorted, tears off the appropriate classification tally roll and attaches it to the batch, which is then ready to be forwarded, completely listed and totalled, to the bank's clearing house. Thus in one operation the amounts are imprinted in magnetic ink on the cheques and deposit slips, they are sorted into their correct classifications, the values are transcribed and proved, a batch tally roll recording the amount on each document and a total for the batch is produced and, finally, a master tally roll containing full details of all entries is printed. Documents are printed and sorted at speeds up to 1,500 an hour.

Which one of these two machines would be used in a particular data processing installation would depend upon the degree of mechanization introduced. If a sorter-reader were available, it would seem unlikely that bank proof machines would be used for printing the amounts on cheques. In systems equipped with sorter-readers it is probable that the cheaper machines—the amount and account number printers—would be employed for this work and that one of these machines would be installed for this purpose, together with an imprinter, in every large branch bank.

In point of fact the bank proof machine was originally developed before magnetic ink character recognition was adopted by the American banks and this machine is more likely to be employed in those systems that do not make use of the E-13B code. In this case the machine would be used exactly as described, the only difference being that the subsequent operations in the data processing sequence would be performed manually instead of by machine and the E-13B characters would not be printed.

At the moment the amount and account number printer and the bank proof machine are only manufactured with keyboards suitable for decimal currencies. Sterling keyboards are being developed, and the first sterling machines will be available later this year. The amount keyboards on both machines are provided with ten columns of keys.

At this stage in the procedure every cheque now has printed upon it in magnetic ink the following data: cheque serial number, bank number, branch number, customer's number, transaction code and amount. These data are arranged along the code line from left to right in the sequence given. Once this information has been printed on the cheques, all the remaining data processing operations can be carried out automatically.

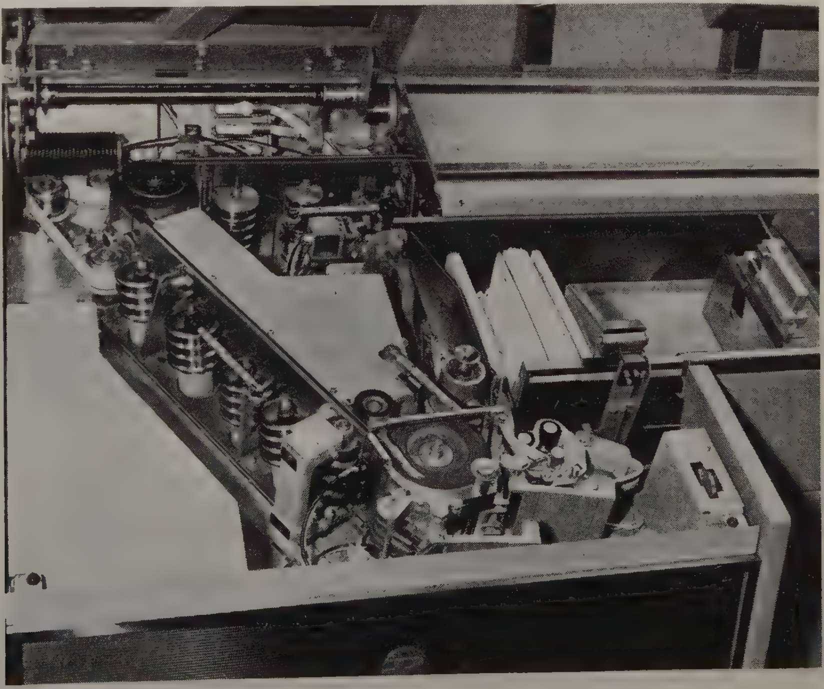
First, the deposit slips and cheques pertaining to the branch performing the final data transcription operation are removed and the remainder are then sent, together with a list giving the amount of each cheque and a total for the batch, to the clearing house for distribution to the other banks.

At the clearing house the principal job is to sort the cheques to banks and later, at the banks' own clearing houses, the cheques are sorted to branches.

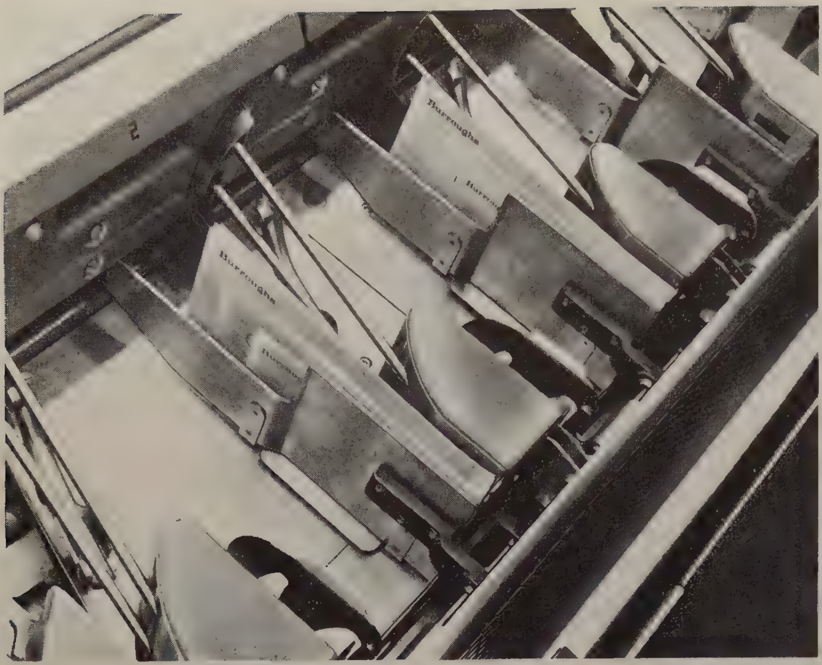
The Burroughs Model B101 sorter-reader sorts cheques of varying shapes, sizes and thicknesses at the rate of 1,560 a minute. As with the punched cards, sorting is performed on one digit at a time. Thus if a sort is to be performed on a four-figure number the cheques pass through the sorter four times.

However, in certain circumstances it is possible to reduce the number of runs by what is known as selective sorting, and a device is fitted to the B101 sorter-reader for this purpose—it will be described later in the article.

Up to 3,600 documents are placed in a hopper on the left of the sorter-reader. From here they are fed, one at a time, beneath a magnet which magnetizes the printed characters



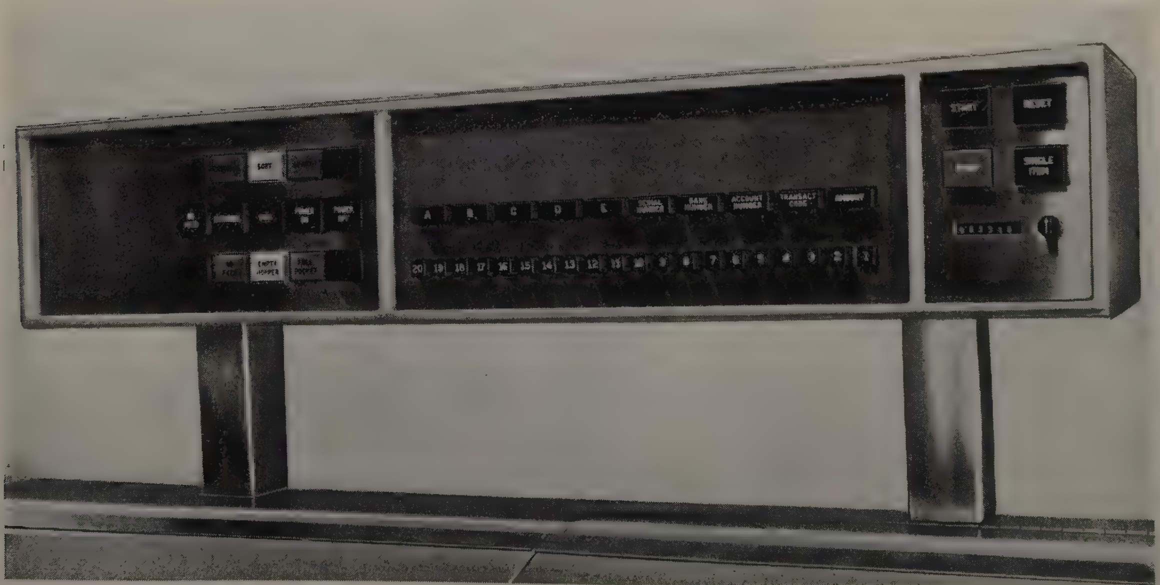
Cheque feeding mechanism of sorter-reader. Documents are transported at a speed of 400 *inches a second*



Cheques of varying sizes and thicknesses can be sorted into the pockets of the sorter-reader

in the code line. Then the documents are transported past a reading head at a closely controlled speed (400 inches per second). The line of characters is read from right to left. As each magnetized character passes beneath the reading head, an electric current is induced in the reading circuit. The strength of the induced signal depends upon the rate of change of flux (or magnetism) which, in turn, depends upon the outline of the printed character. The characters are so designed that the shape of the electric signal produced by each one is unique, and this wave form is identified by the control circuits of the sorter. A signal is then sent to a sorting gate which directs the cheque into one of the 13 storage pockets. From right to left

Control panel of the sorter-reader. For testing purposes, documents may be sorted one at a time



*The Burroughs B*251 *Visible Record Computer designed for banking work*

the pockets are: for rejects, the ten decimal figures 0 to 9 and two additional pockets labelled X and Y. Cheques can be loaded and unloaded while the machine is operating, enabling it to be kept in continuous use.

As already mentioned, normally only one character appearing in a specific location on the cheque or deposit slip is read at a time. A push-button control panel is fitted to the sorter to enable the operator to select both the item of information, that is the bank, branch, account number, etc., and the position of a particular character within that item upon which sorting is to be performed.

Selective sorting

Provision has also been made for a second character to be examined during the reading sequence. If this second character is one that has been specified, an overriding control ensures that the document is directed to either the X or Y pocket of the sorter regardless of the value of the first figure read. This is the selective sorting facility mentioned previously. It is used when the bulk of the cheques to be sorted belong to one particular branch and the branch code number contains a figure which does not appear on any of the other cheques. In one pass, all the cheques for this branch are sent to, say, the X pocket, while the remainder are sorted into the numbered pockets in the usual way. In fact, cheques for two branches can be handled in this manner by using both the X and Y pockets, provided each branch is given a suitable code number.

A counter on the control panel records the number of documents sorted.

Among the other controls fitted on the panel is a "single item" key. Every time it is pressed, one document only is fed from the input hopper and sorted into its correct pocket. This key enables the operator to exercise manual control over the operation of the machine when testing, or when a suspected faulty document is being handled.

Should a document become jammed in the feed mechanism the sorter automatically stops. Emergency stop buttons are also provided at several points for use by the operator.

A B101 sorter-reader costs £35,000 and Lloyds Bank are the first in Great Britain to buy one of these machines. It is to be delivered towards the end of 1961.

Once the cheques have been sorted and returned to the branch banks, the next job at the branch is to up-date the customers' accounts. Where this work is performed on a general-purpose computer equipped with magnetic tape such as the Burroughs 205 or 220 machines, the data from the cheques and deposit slips are transcribed on to magnetic tape by the sorter-lister-converter already described. Alternatively, the Burroughs B251 Visible Record Computer can be used.

This computer is of unique design in that the input data are read directly from the cheques and deposit slips, and the results are printed directly on the customers' account ledger cards and other bank documents.

Normally the B251 computer would be used to keep the accounts of one branch or the accounts of a number of small branches situated in the same locality. Depending upon the activity of the accounts, each B251 computer can maintain the records for 15,000 to 20,000 customers. Of course, in addition to this work the computer performs other accountancy calculations and supplies all the business statistics needed by the bank management. A Visible Record Computer is a transistor machine and costs about £100,000.

The computer comprises four units: a B101 sorter-reader, a central computer and control unit, a document handling and printing unit and an operating console.

When documents are sorted in the normal fashion by the sorter-reader, only one character or, at the most, two are read. However, when the sorter-reader is used to provide input data to the computer, all characters in the code line are read—either this or a specified section of the information. Characters are read in sequence from right to left and the information is transmitted directly to the computer store.

Magnetic-core store

The magnetic-core store is part of the central computer unit. Each computer word contains 10 digits plus a sign, and the store is built up of a number of separate 10-word blocks. Consequently the size of the store can be adjusted to suit the particular application. Additional storage blocks may be added subsequently until a maximum capacity of 100 words is reached.

Programmes that control the operation of the B251 computer are punched in plastic tape. In his right hand the engineer holds a printed circuit board

Programmes that control the operation of the computer are punched in plastic tape. Twelve tape reading units are provided in the central computer cabinet, and programme tapes can easily and quickly be changed when the job to be performed is altered. Up to 2,500 programme instructions can be recorded on the 12 tapes. A library of programme tapes has been compiled by Burroughs covering all the standard banking operations.

Results are printed by the document handling unit. Ledger cards in storage frames are loaded into this unit and the cards are passed one at a time through the machine. New data are printed on the ledger cards, which are then filed in the original sequence in an output storage frame. An auxiliary frame is provided to hold cards that are rejected and require special attention—for example, those of overdrawn accounts.

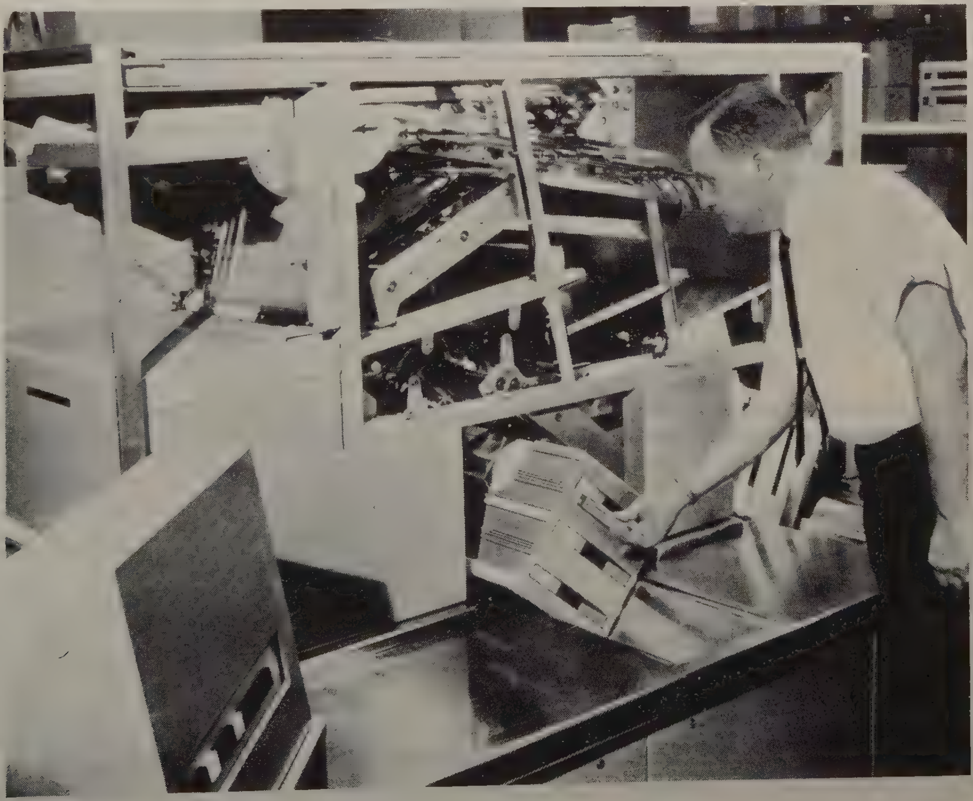
Two form-printing units that record results on continuous stationery are also included in the document handling unit. Lines are printed at the rate of 180 a minute.

The fourth and final unit of the Visible Record Computer is the operator's control console. Additional data can be entered on an accountancy-type keyboard and a dial is provided for the operator to select the particular programme to be performed.

Despite the fact that the Visible Record Computer only has an internal storage capacity for 100 computer words, over 15,000 accounts can be handled. This is possible because of another operational innovation introduced by Burroughs. On the back of each account ledger card are two vertical magnetic stripes, each $\frac{1}{5}$ inch wide. Data printed on the front of the card are repeated as a magnetic recording on the back of the card. Eighty-four digits of information can be accommodated on these two stripes. Besides the current account data, banking control instructions are also recorded: for instance, overdraft limits, repayment orders, bank charges levied, account handling profit-and-loss statement and other statistics of interest to management. By holding all this information on the ledger cards themselves, the computer information storage requirements are greatly reduced. In fact, the magnetic-core store is used solely as a working store where data are held temporarily while being transferred or while waiting for a calculation to be completed. The practice of recording information magnetically on the backs of ledger cards is not new. Burroughs already use this technique with their range of Sensitronic accounting machines.

A typical job performed by the Visible Record Computer is to up-date a group of customers' accounts. All the cheques and deposit slips pertaining to these accounts are first sorted into order and then placed in the sorter-reader. The file of customer ledger cards is placed in the input hopper of the document handling unit. A ledger card is a dual purpose document. On the left is printed the record of the account kept by the bank, and on the right is the customer's statement. The appropriate programme is selected and the machine started. Ledger cards are transported past the printing head at a speed of 200 a minute. Whenever the account number on the ledger card corresponds with the account number printed on the cheque or deposit slip, the card is stopped and a line is printed recording the debit or credit; then the new balance is calculated and printed. At the same time a copy of these entries is produced on

Ledger cards in a storage frame being loaded into the document handling unit of the B251 computer



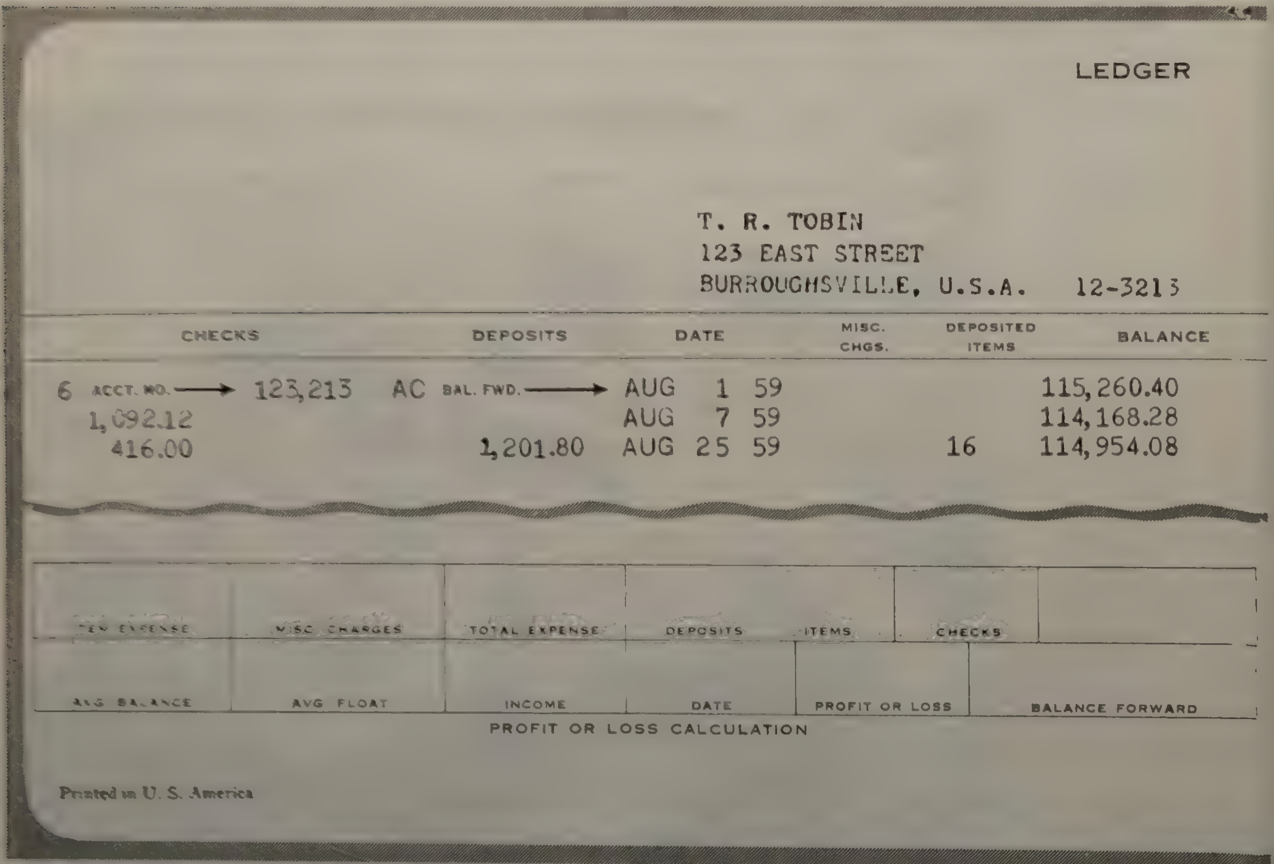
Above. On the back of each ledger card are two magnetic stripes on which the account data are recorded

continuous stationery by one or both of the form-printing units. After being up-dated, the ledger card is released from the printer and sent to the output hopper and the process continues; ledger cards are passed through until the next account to be up-dated is reached. At the end of the posting run, proof totals are printed out for accounting control purposes.

During the posting run the computer exercises normal clerical control over the transactions completed. For instance, instructions can be given to the computer to reject cheques on which "stop payment" orders have been placed and to refuse payment of cheques if an account is overdrawn beyond a specified limit. Also, when a ledger card is full, a new one is substituted automatically: the account number and correct titles are printed on it together with the balances brought forward.

Before a statement is issued the data on the ledger card have to be transferred on to a new card and another programme written for the

Below. Top and bottom portions of the combined ledger card and customer's statement



LEDGER

T. R. TOBIN
123 EAST STREET
BURROUGHSVILLE, U.S.A.   12-3213

CHECKS		DEPOSITS	DATE	MISC. CHGS.	DEPOSITED ITEMS	BALANCE
6 ACCT. NO. →	123,213 AC	BAL. FWD. →	AUG 1 59			115,260.40
1,092.12			AUG 7 59			114,168.28
416.00		1,201.80	AUG 25 59		16	114,954.08

NEW EXPENSE	MISC. CHARGES	TOTAL EXPENSE	DEPOSITS	ITEMS	CHECKS	
AVG BALANCE	AVG FLOAT	INCOME	DATE	PROFIT OR LOSS	BALANCE FORWARD	

PROFIT OR LOSS CALCULATION

Printed in U. S. America

computer controls this operation. While this is being done, the computer calculates whether a bank service charge should be levied or not and, if there is to be one, how much it should be. Then the original ledger card is divided vertically, the right hand half is the statement sent to the customer and the left hand half is kept by the bank as a printed record of the account.

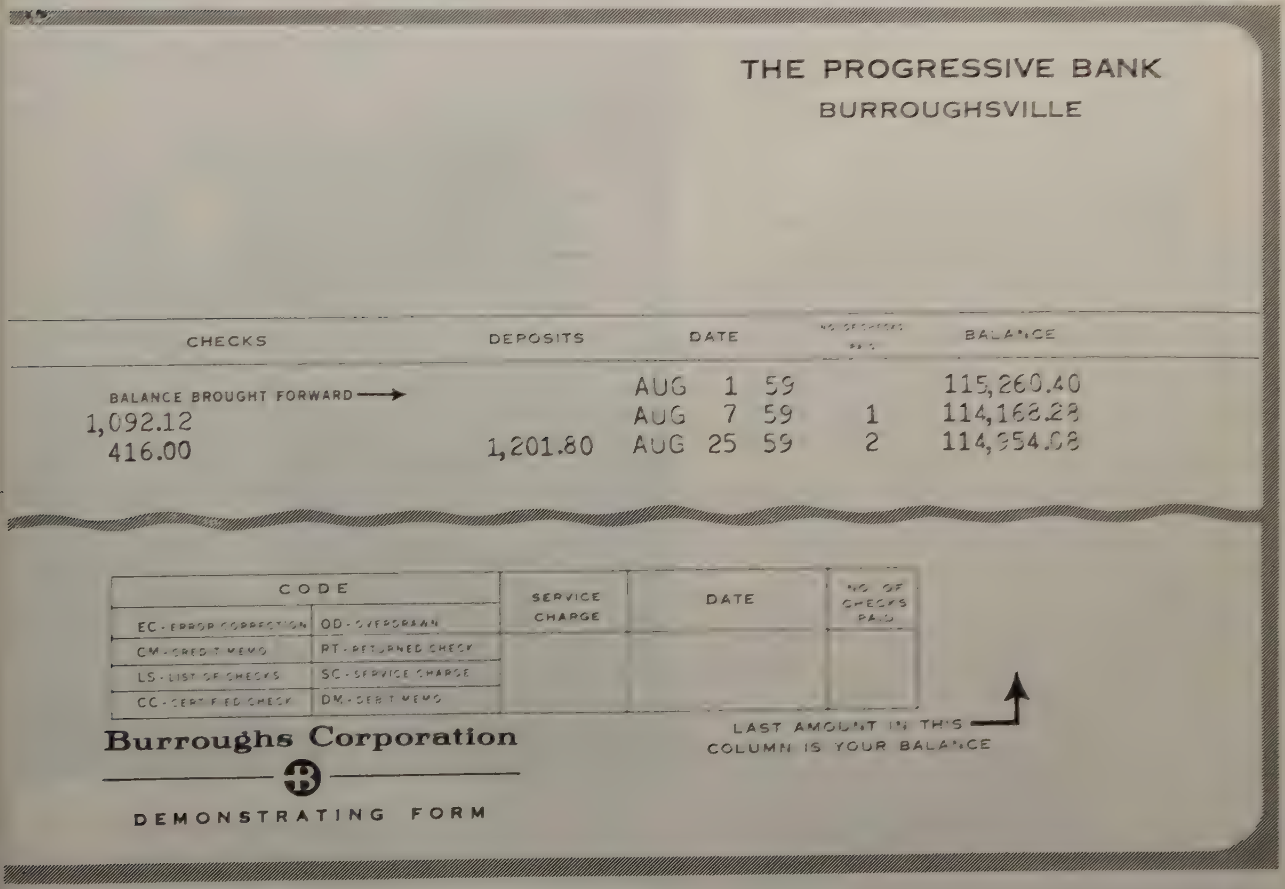
Profit-and-loss statistics

Yet another programme prints an analysis card containing profit-and-loss statistics of each account for the use of the bank management and also provides information on inactive, overdrawn and closed accounts.

In fact, all the normal clerical jobs performed in a bank can be handled automatically by the B251 computer under the control of one operator. Arithmetical operations associated with this work are performed at 4,000 a minute.

Burroughs have always specialized in producing equipment for the banking industry. Indeed, before the E-13B code was designed and accepted by the American Bankers Association, the Company already had under development a cheque sorter that read information in fluorescent ink. This code was invisible to the human eye. However, this initial work was not entirely wasted because the mechanical problems associated with handling paper documents at high speed were successfully solved and, once agreement was reached on the common language code to be used, this enabled the Company to introduce a magnetic character sorter quickly. Incidentally, paper handling was the most difficult problem encountered.

Although the equipment has been produced primarily to meet the needs of bankers there is, of course, no reason why it should not prove suitable for other types of commercial work such as invoicing, sales accounting and the administration of credit and hire-purchase accounts.



THE PROGRESSIVE BANK
BURROUGHSVILLE

CHECKS	DEPOSITS	DATE	NO. OF CHECKS PAID	BALANCE
BALANCE BROUGHT FORWARD →		AUG 1 59		115,260.40
1,092.12		AUG 7 59	1	114,168.28
416.00	1,201.80	AUG 25 59	2	114,954.08

CODE		SERVICE CHARGE	DATE	NO. OF CHECKS PAID
EC - ERROR CORRECTION	OD - OVERDRAWN			
CM - CREDIT MEMO	RT - RETURNED CHECK			
LS - LIST OF CHECKS	SC - SERVICE CHARGE			
CC - CERTIFIED CHECK	DM - DEBIT MEMO			

LAST AMOUNT IN THIS COLUMN IS YOUR BALANCE

Burroughs Corporation

DEMONSTRATING FORM

Capturing commercial data at source

A simple, inexpensive manually operated recorder that costs £135 has been developed by Industrial Accountancy Partnership Limited. It is used by many Co-operative stores for recording retail sales information. As a receipt is printed for the customer, simultaneously the data are punched in a special form of paper tape. Later, this information is transcribed into other machine documents such as punched cards, conventional punched paper tape or magnetic tape.

The object of the system is to provide, at low capital cost, means of capturing data at the moment a transaction is completed. Applications for which the equipment would be suitable are hire-purchase accounting, stock control, wholesale provisioning and sales accounting generally.

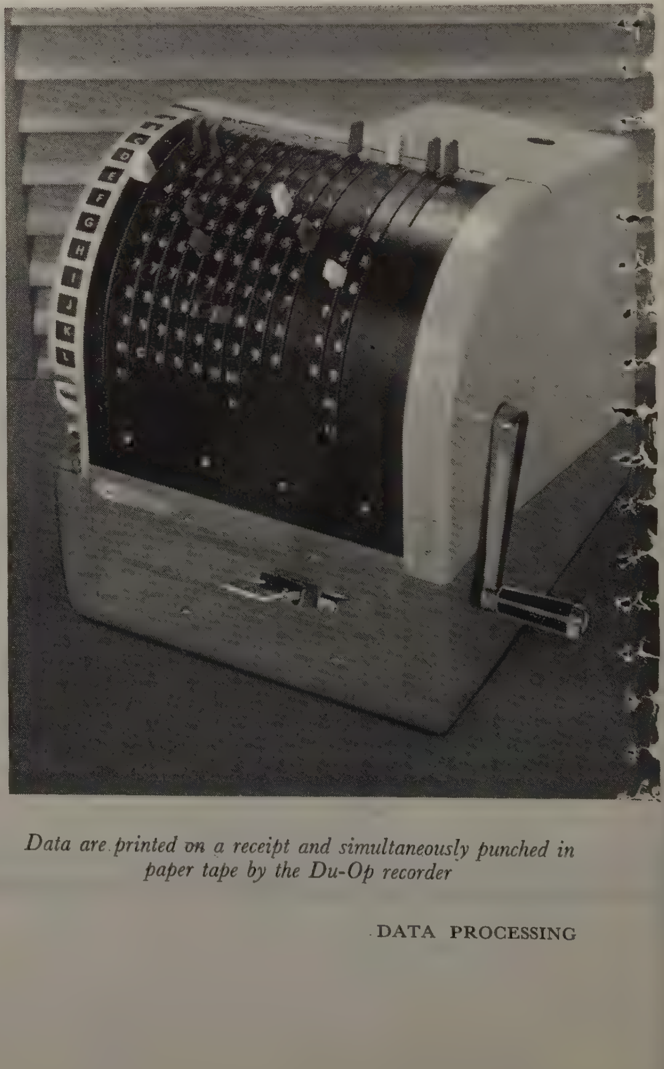
New machines under development include a recording cash register and a card-sensing recorder. In addition to manually entered information, this latter machine records data read from a standard punched card

Du-Op (derived from "dual operation") is the name given to a relatively inexpensive machine system that records data of a sale, or other transaction, in both printed and punched form. At the present time two types of machine are produced—data recorders and data converters.

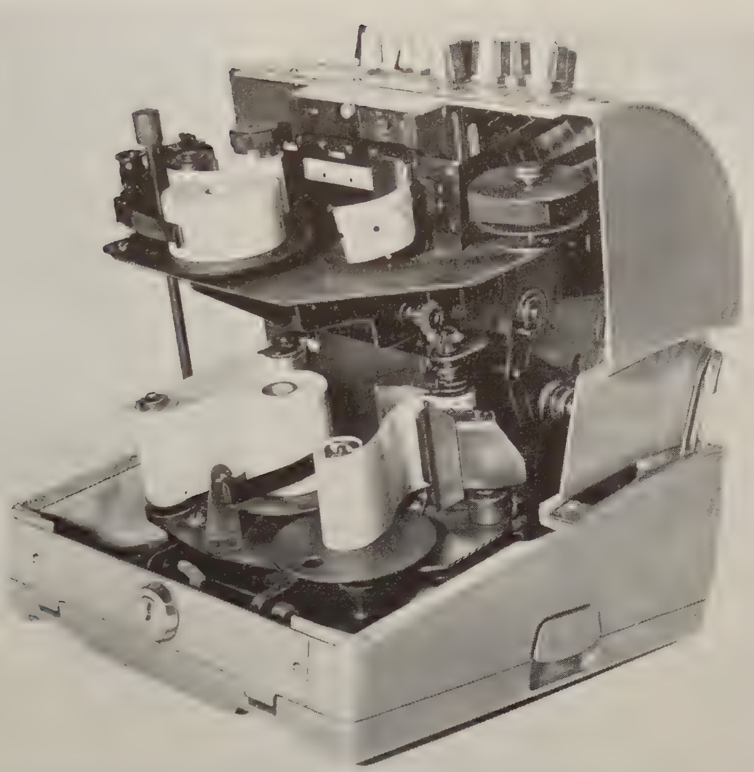
Recorders simultaneously print receipts and punch the transaction data in a special form of paper tape. Up to 16 digits of information are recorded at each operation; this recording capacity may be doubled if required. The recorders are especially suitable for Co-operative Society stores where, of course, values of purchases and customers' membership numbers have to be noted for the purpose of calculating dividends.

As the name implies, converters automatically translate data from the Du-Op tape into other machine documents for use in punched-card and computer data processing installations.

Advantages claimed for this method of recording basic commercial information are: printed receipts are issued and data are recorded in a single operation; clerical labour costs are reduced; transcription errors are eliminated; the assistant's number can be included in the recorded data; and the recorded data are converted quickly and automatically into any other form required.



Data are printed on a receipt and simultaneously punched in paper tape by the Du-Op recorder



Interior of a recorder. Above is the roll of receipts and, below, the 12*-channel punched paper tape*

Capturing basic data can be an expensive business, especially when it is remembered that the capital invested by a large organization in data recording equipment can often equal, and possibly exceed, the cost of the computers and other equipment used to process the information once it has been obtained.

When Industrial Accountancy Partnership Limited started designing commercial data processing equipment, the problem of the large organization that required hundreds of recorders was well understood and one of the major aims was to keep the price of the recorder as low as possible.

Another point borne in mind was that the machines should, as far as possible, be "operator proof"; that is, not susceptible to damage even though incorrectly used.

As a consequence of these two overriding design requirements, it was decided that the recorder should be a simple manually operated mechanical device. It was found that the best way of achieving this was to adopt a simple straightforward punched-hole code. In turn, this meant that a second piece of equipment—the data converter—was required to translate the information punched in the Du-Op tape into the more elaborate codes used in punched cards, conventional punched paper tape and magnetic tape. However, since the converter is a high-speed machine, only one or two would be required in the average data processing installation. And, by arranging the flow of work so that the converters are always fully employed, the costs of data transcription can be kept to a minimum. Working one shift a day, a converter can handle the output of 70 to 100 recorders.

This, then, is the fundamental idea behind the Du-Op data recording system—simple, robust, inexpensive recorders with one or two specialized data converters.

A Du-Op recorder, in basic form, costs £135 and a tape to 21-column punched-card converter costs £2,250.

Transaction data are entered on a recorder by setting 14 selector levers. Numerical data only are recorded and each lever can be set at any one of twelve positions. Normally, these twelve positions are numbered from 0 to 11 to accommodate the full range of sterling currency values, although, of course, the meanings attributed to these positions can be varied. For example, a selector lever is often used to record fractions of a penny or to indicate the type of transaction, whether a cash sale, credit sale, hire-purchase payment or correction.

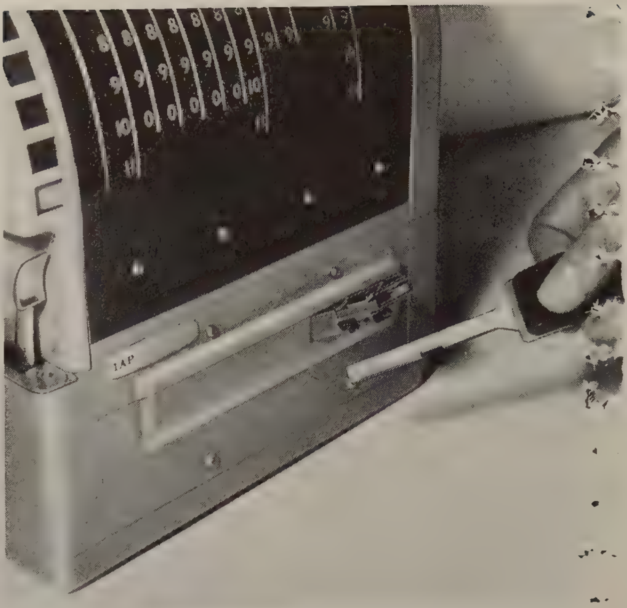
Although each recorder is of similar design, the curved panel containing the slots for the selector levers is manufactured to suit the particular application. The slots do not necessarily extend the full length of the panel. The movement of particular levers is restricted in this way in order to reduce the risk of an operator making an error. For instance, the lever denoting tens of shillings can only be set at 1 or blank and the fractions-of-a-penny lever is confined to one of four positions representing $\frac{3}{4}$d, $\frac{1}{2}$d, $\frac{1}{4}$d or blank. Another aid provided for the benefit of the operator is that the levers used to enter a particular item of information are fitted with knobs of the same colour.

The manner in which the 14 levers are grouped depends, of course, upon the application. For Co-operative stores a typical arrangement is as follows: The lever on the extreme left indicates the type of transaction, the customer's membership number is entered on the next six levers, one lever is for the category of the goods and on the remaining six levers are set the value, in sterling, of the purchase. Finally, before the machine can be operated the assistant inserts a data key which sets up a two-digit number that identifies either the department or the assistant responsible for the sale. The assistant then turns the operating handle on the right of the recorder and a receipt is printed; simultaneously, the data are punched in paper tape.

Data recorded

On the customer's receipt can appear the consecutive number of the receipt (pre-printed on the roll before it is placed in the recorder), type of transaction, membership number, value of purchase and date (a date printer is included in the recorder and is reset manually each day). Except for the date, identical information is recorded in the paper tape together with the category of goods and the sales assistant's code number.

To reduce the risk of the sales assistant making an error, the machine automatically locks should it be incorrectly operated. In the case of the recorder just described, if the seventh lever from the left is not selected the machine refuses to function. In other words, the lever representing the unit value of the member's number must always be set at a figure. Normally a "rest" position is provided for each selector lever; consequently, the lever has to be moved even to record a "0."



A two-digit number that identifies the sales assistant is automatically set in the recorder with a data key

An unusual design feature of this machine is that the metal type which prints the figure on the receipt and the spigot which punches the corresponding hole in the tape are fitted on the same mechanical element; hence it is impossible for the data on the receipt and tape to disagree.

In order to prevent the sales staff from tampering with the mechanism the recorders are kept locked. Usually the departmental manager is supplied with a key and is responsible for removing the punched tape at the end of a day and for returning it to the data processing section. He is also responsible for fitting new rolls of tape and receipts in the recorder. Normally, as each roll contains 500 receipts, this need not be done daily.

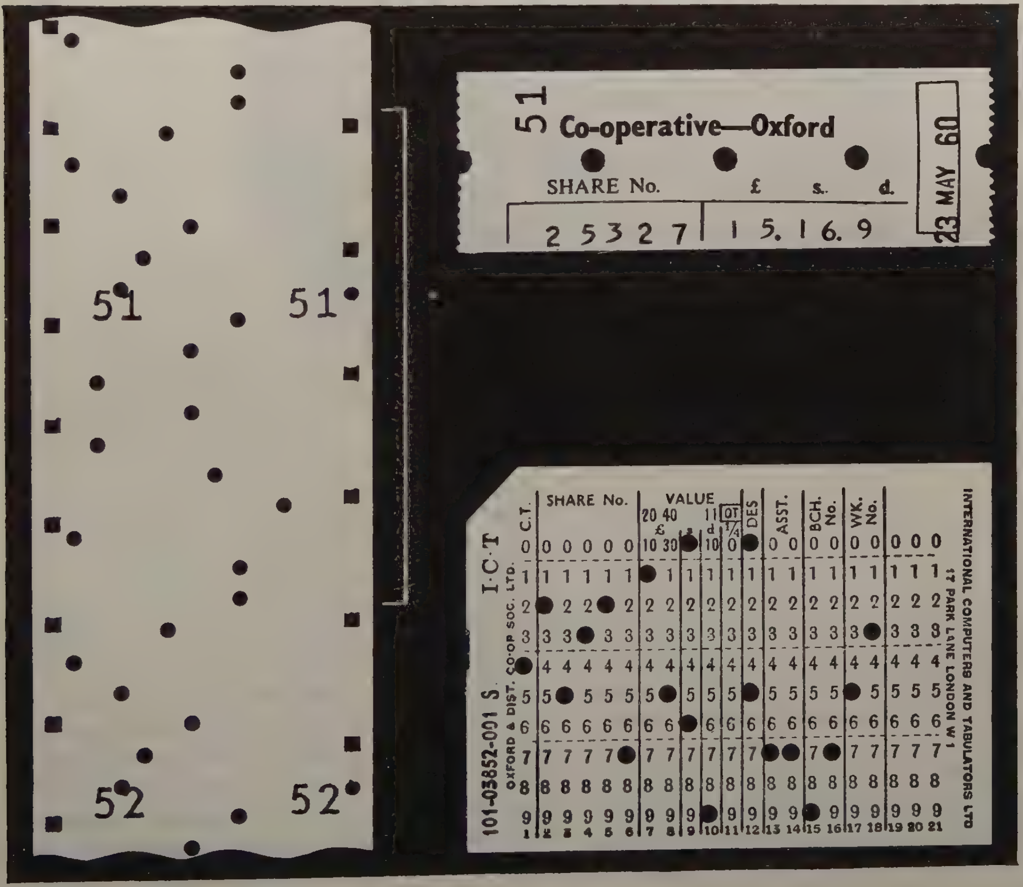
As a safeguard against the recorder running out of tape, or receipts, a window is provided through which the paper supply can be seen and a coloured stripe is printed on the last 20 receipts of a roll. If these preliminary warnings are ignored and the recorder runs out of paper tape during the day, a red indicator knob is raised and the operating handle locks. Thus it is impossible for the operator to set data that will not be recorded.

All 16 digits (14 from the selector levers, plus two from the assistant's data key) are punched in the tape simultaneously and constitute one block, or "frame," of data. A special form of paper tape is used in Du-Op recorders. It is 1¾ inches wide, and down each edge is punched a series of square sprocket holes used for transporting the tape through the various machines. Twelve channels are provided across the width of the tape—one channel for each of the values 0 to 11. This method of recording numerical data is not so concise as a binary or decimal binary code, but, as mentioned previously, the punching mechanism required is much simpler. Also, the principle of "one figure, one hole" avoids the complication and expense of checking the data recorded in the tape to confirm that it has been correctly punched.

Data punched in the Du-Op tape can be converted into any other code and transcribed into any other business machine document such as punched cards, punched paper tape or magnetic tape. The data converters used for this work are built to suit the needs of the particular data processing system. Since many of the early trials of Du-Op equipment were carried out in Co-operative stores, it was natural that the first converters to be constructed translate data from the Du-Op tape into 21-column I.C.T. punched cards (the old Powers-Samas 21-column card so popular with Co-operative Societies throughout Great Britain).

Actually there was one exception to this pattern. The Swindon Industrial Co-operative Society assisted in the early development work and, unusual among Co-operatives, is equipped with 80-column Hollerith punched-card data processing equipment.

A sales receipt (top right), a length of Du-Op tape (on the left) and an I.C.T. 21-column punched card. The square bracket indicates the block of data punched in the tape when the receipt was printed and issued



The 21-column card converter reads all 16 digits from the tape simultaneously and punches this information into 16 columns of the 21 columns available on the card. If preferred, the captured data can be restricted to the first 10½ columns of the card so that the card may be reversed, or "tumbled," and used a second time. This is a common practice and presents no problems as far as the Du-Op equipment is concerned; neither does overpunching data into these cards.

Converters can also be equipped with plugboards on which may be set additional semi-permanent information that is to be recorded in the remaining columns available on the punched cards belonging to one particular batch.

Common information, such as the date and shop reference number, may be entered in this way. To suit particular applications it is also possible to read semi-permanent information from the beginning of a Du-Op tape, store this information in a register within the converter, and punch the data in every card produced thereafter. This continues until the information in the register is replaced by another block of semi-permanent data read from the tape. Special code instructions punched in the tape control this operation.

A Du-Op converter. Data are transcribed from Du-Op tape into 21*-column punched cards at the rate of* 3,600 *blocks an hour*

Data are transcribed into 21-column punched cards at the rate of 3,600 blocks an hour, or the machine can be set to produce cards singly. As mentioned before, this particular converter costs £2,250 and can handle the output of 70 to 100 recorders.

Other types of converter are being built and the transcription speeds of these machines are somewhat higher. As many as 5,000 blocks an hour can be read and recorded on magnetic tape, or punched into conventional paper tape. Naturally the price of these converters varies, depending on the equipment needed to perform the translation from one code to the other, and also upon the number of additional operational facilities required. Over 400 recorders and six converters are already in use.

As a result of the experience gained with these early machines, an improved Mark 2 version of the Du-Op recorder is now being manufactured. Operationally the Mark 2 machine differs only slightly from the Mark I, but detailed improvements have been made to the recording mechanism.

At present, attention is being concentrated on the production of Mark 2 recorders and the 21-column punched-card converters. Meanwhile work is proceeding on the development of new types of recorder.

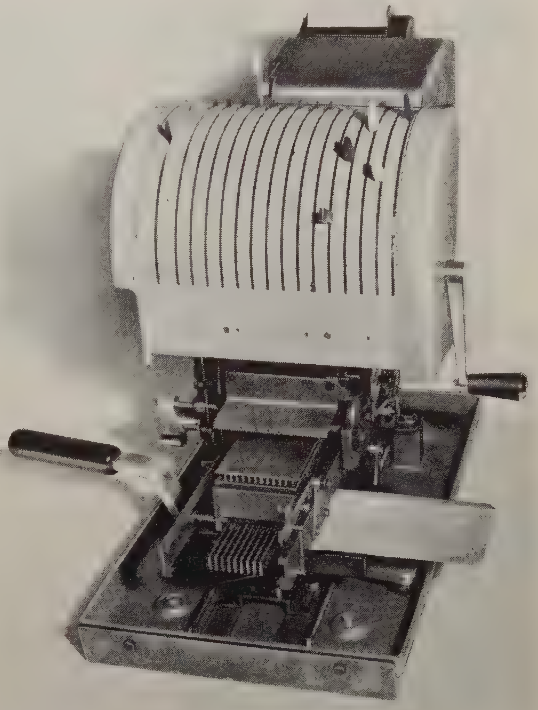
One of the obvious lines of progress is to incorporate a Du-Op unit within a cash register, so that when it is operated the sales data are punched in tape and the receipt printed, both at the same time. This composite machine is to be provided with several totalling registers—items omitted from the basic Du-Op recorder in order to keep the price down.

Another machine being developed is the card-sensing recorder. In addition to recording data set on a bank of selector levers, it can read up to ten digits of information from a standard 80-column punched card. Again, to keep things simple and costs low, it is a manually operated machine, although an electric motor may be fitted where automatic operation is required.

Hire-purchase applications

Potential applications of the card-sensing recorder are numerous; for instance, it would be suitable for hire-purchase work. Every customer is issued with a book containing details of his hire-purchase agreement and, at the back, are several blank pages. Fixed to the rear cover of the book is a section of a plastic 80-column punched card containing the customer's hire-purchase account number and any other relevant permanent information.

When a payment is made, the punched card is unfolded from the back of the book and placed in the reader of the card-sensing recorder. The amount and other variable information, such as the date, are set on the selector levers in the normal way and the machine is operated. At this stage, depending upon the particular application, either a gummed receipt is printed with the amount, account number and date and this is stuck in the book, or this same information is stored by the machine while the book is withdrawn from the reader and placed in another unit on the machine which prints the transaction data directly on to one of the blank pages. Simultaneously the data read from the card and set on the selector levers are punched in Du-Op tape. After the receipt has been entered by either of these methods, the book is handed back to the customer. Thus, in one operation, the customer's payment is acknowledged and a punched tape containing details of the transaction is produced. Incidentally, the card-sensing recorders that issue gummed receipts are also equipped with tally roll printing units which produce printed lists of data punched in the Du-Op tapes.



A prototype card-sensing recorder that reads up to ten digits of additional data from a standard punched card

Of course, the great merit of this scheme is that the customer's account number is always recorded correctly. All the inaccuracies resulting from customers quoting wrong numbers, or sales staff making similar errors when writing out receipts, are avoided.

Selective addressing

Machines which automatically select and print addresses from a file of unsorted master cards

Each hole punched in the frame of an address master card represents a characteristic of the person named on the card.

Selector pins in the machine are set to detect specified holes and, as each address card goes through, the machine will either print the address or pass the card by according to whether the holes punched are those required or not.

The machines are used for addressing letters and labels, and also for maintaining and gathering statistics relative to subscriptions, sales promotion and accountancy.

Cost of a machine complete with an automatic card selector ranges from £650 to £750; alternatively the selector unit can be fitted to any standard general-purpose electrically operated Elliott Addressall machine for approximately £150

EVEN where automatic addressing machines are available, it is often necessary for someone to select the address cards or embossed plates to be used. To overcome this problem Elliott Addressing Machines Limited have built a device that automatically selects specified address cards as they pass through the machine. A series of pins, set in a panel, sense holes punched in the frame of the card in which the address stencil is mounted. A tray of address cards is placed in the machine and the printing head operates whenever a card containing the correct pattern of punched holes is detected. Address cards that do not contain the specified punched holes pass through the machine without operating the printing head.

All the operator need do is to load the address cards into the machine and see that sufficient blank address labels or envelopes are available. Cards pass through the machine at between 3,600 and 5,000 an hour.

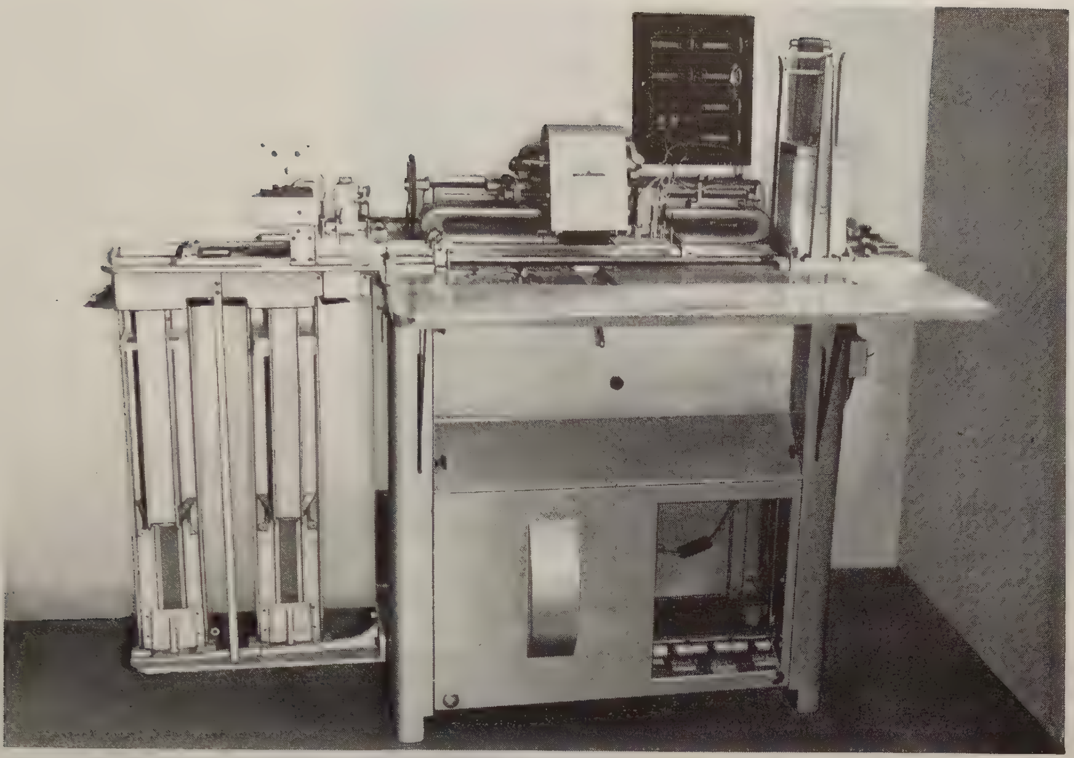
The selector unit can be attached to any standard general-purpose electrically operated Elliott Addressall machine and costs approximately £150.

In addition to being fitted with a selector unit, an Addressall machine can be equipped with several other attachments. One of these counts the number of address cards that contain specified punched data; another overprints data on selected cards or labels as the latter pass out of the machine. Others give audible warning when certain cards are selected for printing, sort address cards into two different receiving hoppers or punch code holes in specified cards.

Many uses have been found for this equipment by commercial, industrial and publishing companies. A typical application is printing addresses on envelopes or brochures that are to be despatched to particular groups of customers. The machine is set to select and print the addresses of all customers fulfilling conditions specified by the sales office.

Similarly, if an industrial firm wishes to inform all users of a particular type of equipment that a modification has to be included, or that a new attachment is available, the machine can be set to select and print the appropriate addresses from all those recorded in the main customer file. And, finally, these machines are used by many publishers for addressing sales letters to persons having known interests or to prepare wrappers for distributing magazines by post, automatically excluding the addresses of readers whose subscriptions have expired.

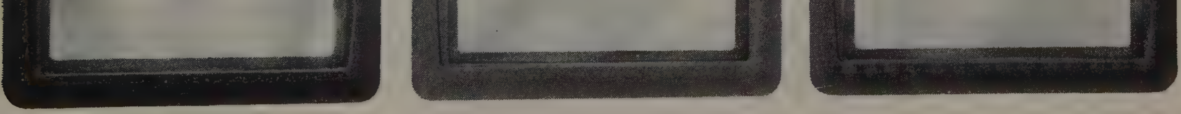
An Addressall card is $4\frac{1}{16}$ inches wide by $3\frac{15}{16}$ inches deep. It is made from paperboard about $\frac{1}{32}$ inches thick and has an aperture pierced through the lower portion which contains the silk stencil bearing the name and address. (The usable area for the address measures 3 inches by 1 inch.) Normally the



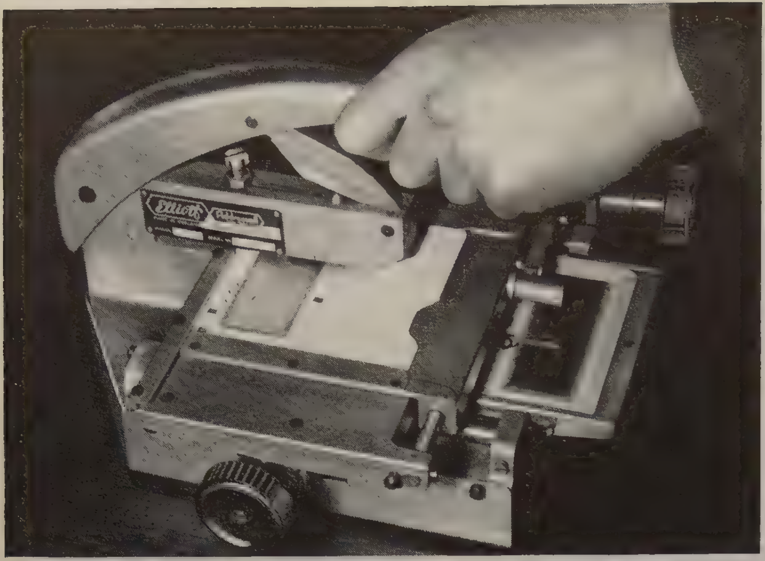
Address cards are selected and printed automatically at speeds of between 3,600 *and* 5,000 *an hour*

name and address are also printed on the card above the silk stencil so that they may be more easily read. It is stated that more than 10,000 impressions can be obtained from each master card.

All the data needed for the selection operation are recorded as square holes punched through the frame of the card. Each hole represents a code number, feature or characteristic of the



Various designs of address card. Provision can be made for a maximum of 120 *punching positions*



(Left) The square holes are punched in the frame of the address card manually

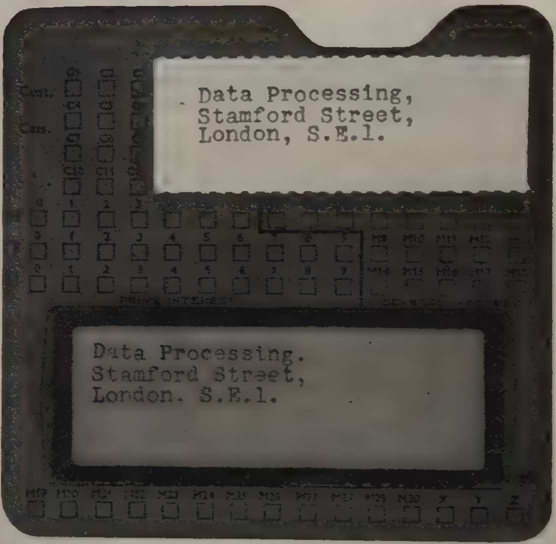
(Below) An address card containing 72 hole positions

person, or company, whose name and address appear on the card. The holes are $\frac{1}{8}$ inch square and are arranged in rows across the width of the card. Each row contains 15 holes and four rows are provided on a card. An additional 12 holes can be punched in the top left-hand corner of the card, but where more than 72 holes are required, if the space usually reserved for printing the name and address is encroached upon, then as many as 120 positions can be made available.

No standard punched-hole code exists, because each automatic addressing system is designed to suit the needs of the particular company that uses the equipment. Nevertheless, a typical, though fictitious, code for a card with 72 hole positions will be described to show the types of information that can be recorded.

In the top left-hand corner of the card illustrated on the right are twelve numbered holes prefixed with the letter C. These are used to indicate the type of customer. A hole is punched in C1 if he earns over £5,000 a year, in C2 if he earns from £2,500 to £5,000 a year, in C3 if he earns under £2,500, C4 indicates that he is a house owner, C5 a car owner, C6 a television owner, C7 married, and so on.

Beneath this set is another group of 27 holes arranged in three rows, which span just over half the width of the card. The letters H, T, U printed at the left-hand end of each row indicates hundreds (only 7 holes available in this case), tens and units. Numerical values up to 699 can be recorded in this area by punching



three holes in the appropriate places. The remaining hole positions on the card are used to denote any other important characteristics of the person.

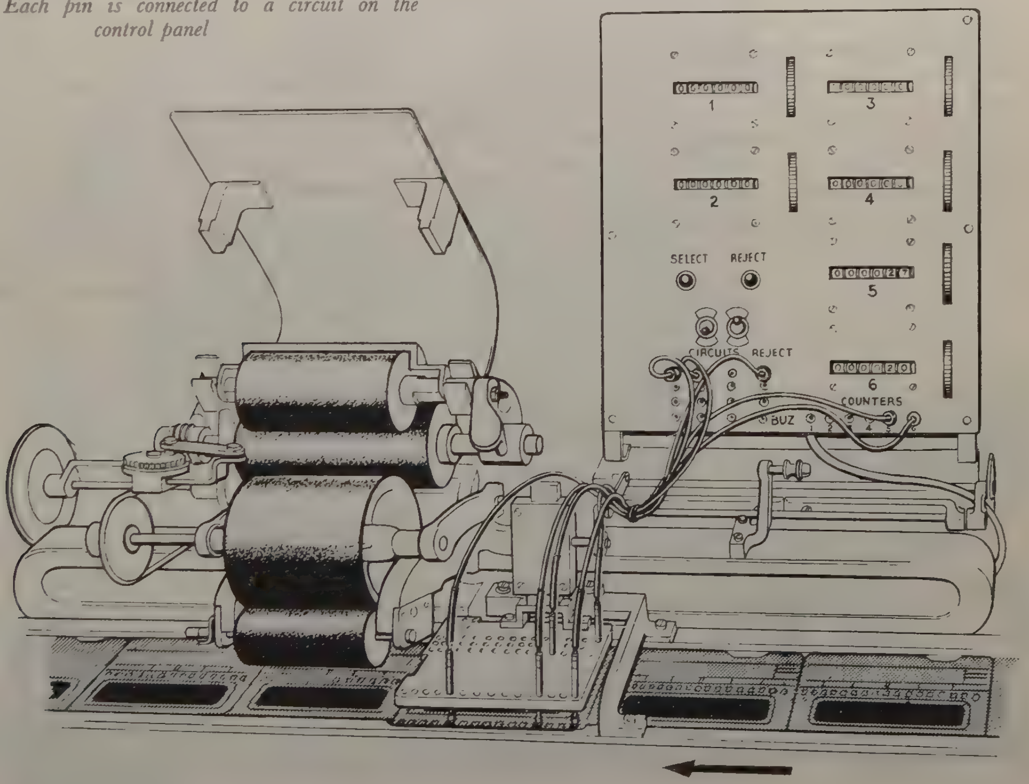
These holes control the selections made in the following manner. A tray of address cards is placed in the input hopper of the Addressall machine. Cards are fed automatically one at a time from the hopper along a track that passes beneath the printing head. Just before the card reaches this position it passes underneath the data-sensing unit. This is a transparent plastic plate that contains a hole to match every hole position printed on the address card. Spring loaded selector pins, connected by electric wires to a control box on the machine, are fitted in this plate to detect holes representing features on which the selection is being carried out. As an address card passes beneath the sensing unit the plate is lowered bringing the selector pins into contact with the card. Where a selector pin coincides with a hole, it passes through the card and impinges on a metal plate beneath, so completing a 12-volt circuit and closing an electric relay. If the required pattern of holes is detected by the selector pins, all the relays in the control box are closed and the machine prints the address as the card passes beneath the printing head. Otherwise the card passes through and nothing is printed.

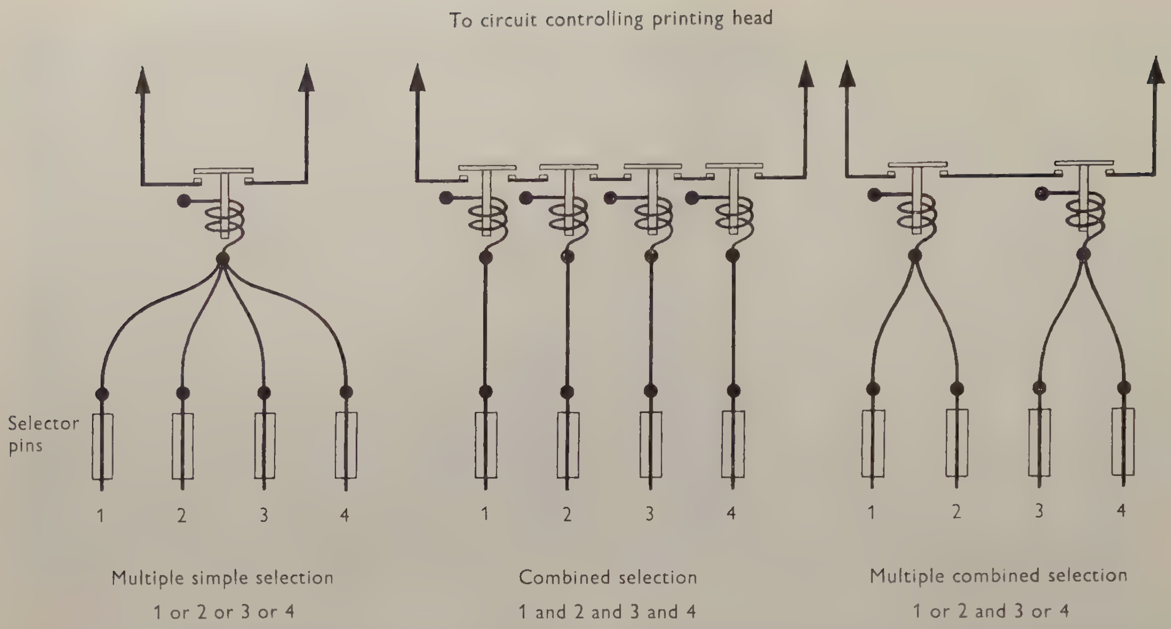
There are two basic ways in which cards can be selected. In one—known as simple selection—the addresses on all cards having a hole punched in one specified position are printed. Thus, the addresses of all car owners may be required, in which case a selector pin is fitted in the hole marked C5 of the selector plate. Then, as the cards pass through the machine, the addresses are printed from all cards in which the C5 hole is punched. Many of the cards might have other holes punched in them, but these do not influence the selection.

It is also possible to perform what might be called a multiple simple selection. In this case the addresses of all persons who, say, own a house *or* a car *or* a television set would be printed—that is the addresses are printed from all cards with a hole punched in the C4, or C5, or C6 positions. To make this type of selection, the three pins fitted in the selector plate in locations C4, C5 and C6 are all connected to the same electric circuit in the control box. Therefore, it does not matter if the circuit is completed by all three pins or only one, the effect is the same—the address is printed.

The second method of selection—called combined selection—involves printing the addresses of persons who possess a range of characteristics. For example, maybe only the addresses of people who own a house *and* a car *and* a television set are to be printed. For this purpose selector pins are fitted in the selector plate positions C4, C5 and C6, as before, but this

To the right of the printing head is the plate containing the selector pins. Each pin is connected to a circuit on the control panel





Three methods of selecting address cards. When all the relays in the control circuit are closed, the printing head is operated

time they are connected electrically to three separate circuits in the control box. Only when the relays of all three circuits are closed, that is, when a card having all three holes is detected, does the machine print.

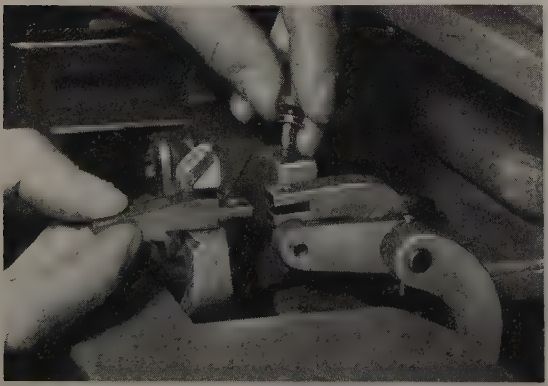
Of course, it is also possible to perform multiple combined selections. Thus, a selection might be made on the basis of the person owning a house *or* a flat, *and* a car *or* a motor cycle, *and* a television set *or* a radio.

The number of features that can be included in a combined selection depends upon the number of separate circuits provided in the control box. As each panel is made to suit the particular needs of the customer, the number of circuits available differs from machine to machine, although five may be considered to be an average number. A switch is provided on every circuit so that the circuit may be isolated when not required for a particular selection sequence.

In addition to the circuits described, another circuit—a reject circuit—is provided in the control box. In some circumstances it may be desirable not to print the addresses of certain people who, in all other respects, fulfil the conditions on which the selection is being made. In these cases a reject selector pin is set to sense another hole punched in the card. Then, even though all the required circuits are energized and the selection is complete, the presence of the reject hole causes the control circuit to be broken and that particular card passes through the machine without the address being printed. Consequently it is possible to select and print the addresses of all persons owning a house *and* a car and omit those who, in addition, possess a television set. In other words, the pin in the C6 hole of the selector plate is connected to the reject circuit.

Coloured lights on the control panel indicate whether the address on the next card to pass under the printing head is to be printed or

By inverting a trip block, negative selections can be made



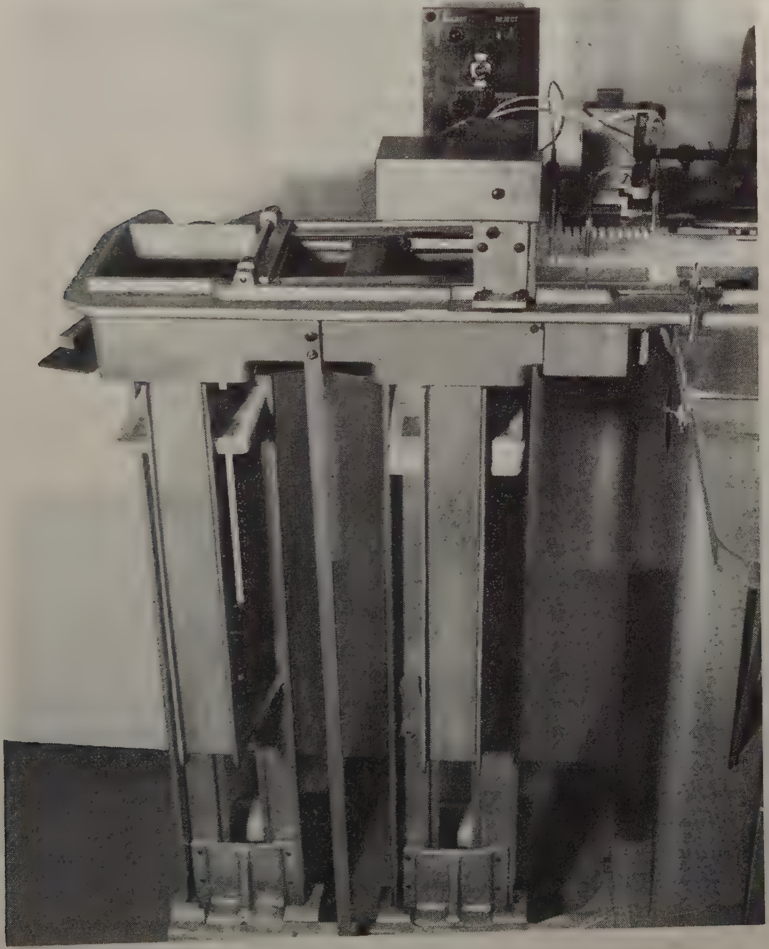
missed—a green light appears when a card is selected and a red light when it is rejected. Basically, this is the way in which the Elliott Addressall automatic address-selection system works.

Except when the reject circuit is used, the methods of selection described are all positive—if a card contains the required holes the address is printed; if not, the card passes through unprinted. By inverting a small trip block controlling the printing mechanism it is possible to perform what is termed negative selection. Then addresses on cards containing all the required holes pass through unprinted and the addresses on all cards not containing the holes are printed.

With the machine operating in the negative manner the type of selection made is to print the addresses of all persons who do *not* own a house *or* a car, etc. This method of selection is useful because obviously in certain cases it is easier to specify the people to whom letters are not to be sent than to specify those to whom letters should be sent. Also, when preparing the machine, it is quicker to fit a few selector pins specifying features not required than to fit a larger number of pins identifying features that are required. When the machine is operating in the negative sense, if a reject hole is detected in a card the address is always printed.

Ancillary attachments

Other ancillary devices can be attached to Addressall machines and operated either in conjunction with the automatic selector or as independent units. Normally only one copy of the address on a selected card is printed, but a unit is available which causes the machine to print two, three or more copies as required. Another device is a sorting gate which directs selected address cards to a second output



As cards are ejected from the machine they are automatically sorted into two hoppers hopper when they are ejected from the machine. In this way cards relating to, say, expired accounts can be removed automatically from the main card file.

Control totals and other statistics are often needed and numerical counters operated by the selector unit can be fitted to the machine for this purpose. An electric counter is connected to one of the selector pins; then, every time a card containing the appropriate hole is detected the total recorded is increased by one. Incidentally, counting need not be restricted to those features used to determine whether the card is to be selected for printing or not. An additional pin can be fitted in the selector plate solely to operate a counter. Consequently a count of all television owners can be made while the machine is printing the addresses of all car owners.

More than one counter can be used and many different totals can be compiled simultaneously. To make the machine-preparation procedure simpler, a separate selector plate can be fitted for the purpose of holding the selector pins that operate the counters. A mechanical counter can also be provided to record the number of address labels printed during a particular run.

Two other features of interest on Elliott Addressall machines are an audible warning device and an overprinting unit.

When copies of a handbook or a brochure are mailed, certain people may have to receive more than one copy. This may necessitate the printing of a parcel label instead of a wrapper. Special holes punched in the appropriate cards cause an audible warning to be given to the operator, who can then feed in a parcel label.

In a similar manner, whenever a special hole is detected in a card, an overprinting unit can be operated automatically to impress a date or reference number on the label. It is also possible to punch additional holes in the frames of selected cards before they are ejected from the machine.

An Addressall machine complete with an automatic card selector unit costs from £650 to £750 depending upon the number of control circuits and other facilities required. A card-sorting unit, including the gate which diverts the cards into the two receiving hoppers, costs £120 and the price of an electric counter is £11. All these items can be added to standard Elliott Addressall machines already in service.

By fitting an automatic selector to an addressing machine the latter's versatility is greatly increased. Where address cards can be kept segregated into groups according to the purpose for which they are required, an automatic selector is not needed. But in the majority of businesses, although the addressing system might have been designed to operate in this way, new requirements inevitably arise which make manual sorting and selecting of address cards necessary. If an automatic selector is fitted, this work is eliminated and, if counters are also fitted to the machine, valuable statistics can be obtained as a by-product of a normal printing run.

Up to the present, the application for which Addressall machines equipped with automatic card selectors have proved most popular is the preparation of address labels, envelopes and lists for sales promotion purposes.

A typewriter is used for printing the address on the stencil of a master card. To hold the card a special attachment is fitted in place of the typewriter platen

Controlling city traffic by computer

Varying the operation of traffic lights—whole series of such lights—to suit the flow of traffic

Whenever anything has to be organized, a computer of suitable design can generally be arranged to do it as effectively as a man—if not better. The versatility of computers is demonstrated anew by the fact that they are now being employed to alleviate one of the ills of modern city life, traffic congestion. Since February, 1955, the operation of a system of traffic lights in Baltimore, U.S.A., has been controlled by a computer which receives information on the density of the traffic moving along the various routes and regulates the lights accordingly. This is a continuous operation and as the traffic pattern changes, so preference is given to the routes carrying the densest streams.

The system installed at Baltimore was built by the Automatic Signal Division of Eastern Industries Incorporated, of East Norwalk, Connecticut, U.S.A. Other cities in the U.S.A. have also introduced computer-controlled systems and it is stated that, among the beneficial results, the average speed of traffic in city centres has increased by 50 per cent and, in one case, a traffic lane formerly handling 450 cars an hour now handles 1,200.

Traffic density is measured by radar detectors located above each traffic lane or by vehicle-operated pressure pads set in the road surface. Signals from the traffic detectors are transmitted by landline or radio link to a master control unit which is, in effect, an analogue computer plus a number of electronic timing and switching circuits. By comparing the signals received from the different vehicle detectors, the computer determines which roads are carrying the heaviest traffic and the direction in which the traffic is heading. Then, by sending control signals by landline to the local units which operate the traffic lights at each intersection, the timing of the signals is adjusted to suit the traffic pattern.

When the density of traffic is increasing, the local controller receives instructions from the computer to increase the "green" time allocated to that particular route. Similarly the green time is reduced on the transverse route. Any one of six pre-set time cycles can be selected by the computer to suit traffic conditions. Only the length of the green interval is altered; all other time periods of the signal cycle remain fixed, because, of course, the time allowed for traffic to clear the intersection before the red light changes to green on the transverse route, or the time allowed for pedestrians to cross, cannot be reduced without affecting safety.

The other variable controlled by the computer is the time interval that elapses between the lights at one intersection turning green and the changing of the lights at the next intersection. Obviously this interval has to be adjusted to suit the rate at which the traffic flows. Also, to allow for the reversal in traffic flow that occurs between the morning and evening rush hours, the sequence in which adjacent sets of traffic lights operate has to be reversed.

Although the computer constantly adjusts the operation of the lights, it does this progressively so that the existing traffic flow is not disrupted.

In simple terms this is how a computer-controlled traffic system operates. There are various refinements to meet the needs of crossings where more complex flow patterns are encountered. Also, where appropriate, a certain degree of local control can be exercised over a set of traffic lights by pedestrians.

Many new ideas for controlling traffic by computer have been suggested. One is that the computer could indicate to drivers the best route to follow to reach a given destination, taking into account present traffic conditions. This would be done by illuminating direction signs and diverting traffic from a heavily loaded route on to an alternative route.

Another scheme is that the number of vehicles passing through a ring of traffic lights enclosing the centre of a city could be counted and when saturation point was being reached the inward flow of traffic would be halted.

Reading machines

Development and application of Farrington print readers

At the moment the only documents read reliably by machine are magnetic tape, punched paper tape and punched cards. Several companies are working on machines that read print, but all the machines built to date are limited to recognizing one particular design of script. In many cases the styles of these scripts are accentuated to simplify the task of mechanical reading. Obviously the desirable solution is that machines should be capable of reading both printed and handwritten information direct from normal commercial documents.

In Great Britain the Solartron Electronic Group are developing an automatic reading machine, the ERA*, for reading information printed on cash-register tally rolls. Also, EMI have produced a machine that reads highly stylized figures. In the United States similar work has been conducted by the Intelligent Machines Research Division of the Farrington Manufacturing Company. A total of 27 print-reading machines built by that company are now in service of which fifteen are used by oil companies for reading credit sale invoices. These machines read the account numbers from customers' invoices and punch the data into cards. Three similar machines are used by the First National City Bank of New York for reading account numbers and values from travellers cheques.

Reading at 200 characters a second

Recently, the most advanced reader yet constructed by the Farrington Manufacturing Company was delivered to the United States Air Force Air Research and Development Command. This machine reads 200 characters a second from a normal typewritten page. Although it is restricted to one style of type, both capital and lower case letters can be read and also numerals and punctuation marks. The typeface read by the machine is a slightly modified version of Financial Gothic specially developed for the purpose by Farrington. An example of this fount is shown in the accompanying illustration—note the accentuated letter "i."

Characters are read one at a time. This is done by the reading head scanning the image of the character line by line, just as a television camera scans a picture. The reflected image is projected through a scanning disc into a photo-multiplier (an extremely sensitive photo-electric cell) and the electrical signal produced represents the character read. By means of "logic" circuits, this electrical signal is identified and converted into an appropriate code suitable for direct entry into a computer or other data recording equipment such as a paper tape punch, a card punch or a magnetic tape deck.

With mechanical reading, the task of converting the printed character into an electrical signal is not difficult; the real problem is to design "logic" circuits which can unfailingly recognize the signal although the character may be misplaced, distorted or otherwise mutilated. This is the principal reason for restricting the reading ability of the machine to one script; it simplifies the task of designing the "logic" circuits.

Known as the MX-2021, the reader built for the Air Force is to be used for indexing and abstracting technical information. The Air Force already use machines for this work, but first the data have to be transcribed manually on to documents such as punched cards or punched tape that can be read automatically. If the introduction of the print reader is successful, manual transcription will, of course, no longer be necessary.

Recently, the Intelligent Machines Research Division was awarded a development contract worth £40,000 to build an address-reading machine for the United States Post Office. It must be able to read typed or printed addresses, with lines at single or double spacing, positioned anywhere on the face of any size of envelope. After the address has been read, the machine is to direct the letter to one of 40 chutes.

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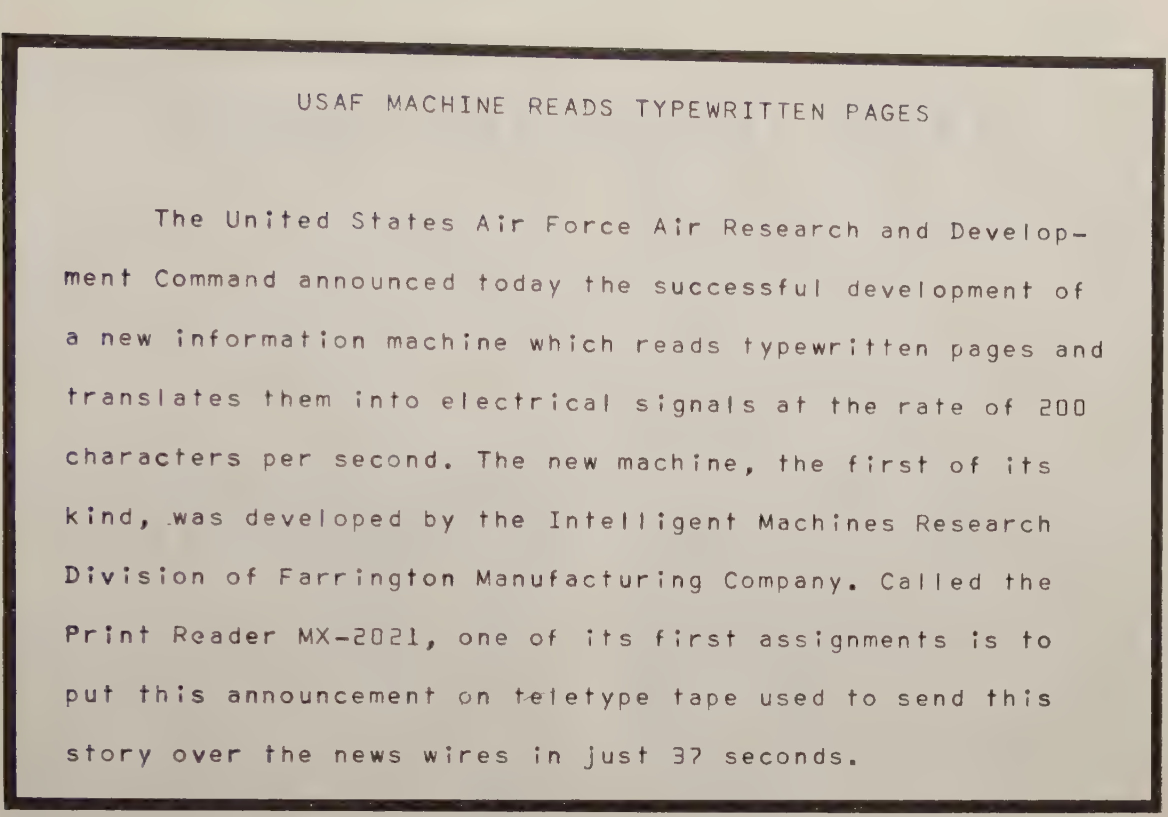
*See "Automatic reading," *Data Processing*, January-March, 1959.

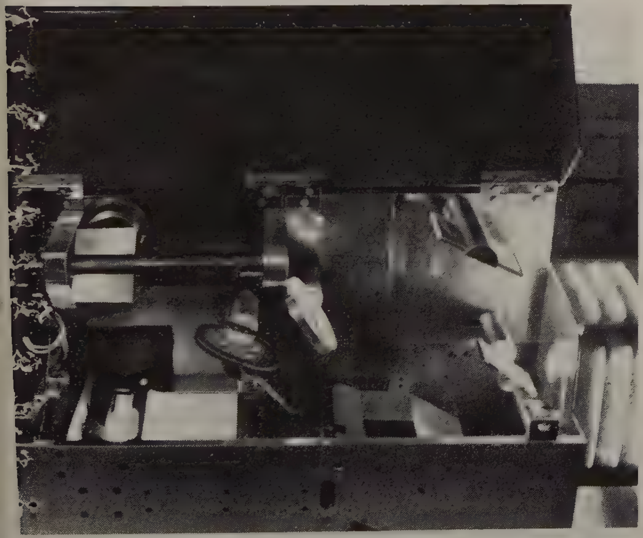


USAF MACHINE READS TYPEWRITTEN PAGES

The United States Air Force Air Research and Development Command announced today the successful development of a new information machine which reads typewritten pages and translates them into electrical signals at the rate of 200 characters per second. The new machine, the first of its kind, was developed by the Intelligent Machines Research Division of Farrington Manufacturing Company. Called the Print Reader MX-2021, one of its first assignments is to put this announcement on teletype tape used to send this story over the news wires in just 37 seconds.

Example of the modified script read by the MX-2021 print reader at a speed of 200 characters a second

The "eye" of the MX-2021 print reader. Both capital and lower case letters can be read and also numerals and punctuation marks



Although the new machine is intended to sort letters into 40 groups, provision is being made for it to read a larger number of destinations. Letters are to be sorted at the rate of 10,000 an hour—this is three times faster than the speed at present achieved by manually operated semi-automatic sorting machines. The first production model of the address reader is to be completed in 1961.

This work is all part of a scheme to develop a completely automatic letter sorting system. The United States Post Office and Farrington already have some experience of the problems involved, because an experimental address reader that sorts letters into 20 groups has been undergoing trials in Washington since September, 1959. The hope, of course, is that ultimately there will be machines that can read both handwritten and printed addresses and research to this end is being carried out for the Post Office.

In addition to designing and building optical readers, Farrington is developing a machine that can read characters printed in magnetic ink.

Data processing topics

5-million insurance policies on a KDP 10 computer

In 1962 the Commercial Union Group of Assurance Companies in Great Britain are to use an English Electric KDP 10 data processing system (worth £300,000) to keep the records of five million policies. Details of transactions will be transmitted every day by private teleprinter from the various Commercial Union offices to the KDP 10 data processing centre. Here considerable numbers of documents will have to be printed and two Xeronic printers will be employed on this work. Use is to be made of the facility, available with Xeronic printers, to print the outline of the form as well as the wording, thus eliminating the need to carry large stocks of pre-printed stationery. The Xeronic printer was described in "High-speed printing," *Data Processing*, January-March, 1959.

Emidec 1100 deliveries

The first two Emidec 1100 computers were delivered in Great Britain recently. Throughout the remainder of the year, deliveries are scheduled to take place at the rate of one a month. In the near future, two of these machines are to be shipped to the U.S.A.

Computers in local government

More local government authorities are installing computers. Recently Durban City Council in South Africa took delivery of an I.C.T. 1202 computer, Eric—the London County Council's IBM 650 computer—was commissioned in April, and the Cornwall County Council now have an I.C.T. 555 plugged-programme computer.

The Durban City Council is the first municipality in South Africa to employ a computer; it will be used to prepare electricity, water and telephone bills as well as the Council's payroll. It is estimated that it will save the Council more than £15,000 a year.

IBM 1401 orders

Since the 1401 was announced last year, it is reported that over 3,500 orders have been received for this IBM computer. Of these, 450 are from Europe. More than fifty are for companies in Great Britain.

Automatic warehousing—automatic supermarket

Solartron-John Brown Automation Limited has acquired the world rights, excluding America, of the Gumpertz automatic warehousing system—a system likely to be used extensively in automatic supermarkets of the future.

On entering the shop the customer picks up a blank card similar to a factory time card. Samples of the goods offered for sale are displayed, and when the customer wishes to make a purchase she places the card in a slot adjacent to the item, whereupon the name, size and price are printed on the card automatically. Proceeding on her way, the shopper compiles her order. Finally, the shopper posts the card in a slot at the cash desk. Data printed on the card are read automatically, the prices are added up and the total is displayed on an indicator to both the shopper and the cashier. After the money is paid, the cashier presses a release key and, within 15 seconds, the goods are automatically selected from a warehouse on the floor above the shop and delivered to a booth for the customer to collect.

The Gumpertz system may also be used with punched card, punched paper tape or keyboard data processing equipment.

Air traffic controlled by computer

On April 25th, tests began at the U.S.A. Federal Aviation Agency's experimental centre at Atlantic City, New Jersey, with a computer specially built by General Precision Incorporated for air traffic control work. It is designed to handle 440 flights an hour, during which time as many as 1,600 progress reports can be printed. It can also control the sequence of arrival and departure of up to 90 aircraft an hour.

Similar experiments are to be conducted in Great Britain by the Ministry of Aviation. In the spring of 1961 a Ferranti Apollo computer is to be installed at the air traffic centre Redbrae, Prestwick, Scotland, to control aircraft flying on the North Atlantic route.

International symposium

An international symposium on data transmission, organized by the Benelux section of The Institute of Radio Engineers, is to be held at Delft, Netherlands, on September 19th, 20th and 21st, 1960. The symposium will be conducted in English and will be concerned with the problems of transmitting and receiving information in digital form. Address for further information: The Benelux Section, IRE, Postbus 174, Den Haag, Nederland.

Commerce and science—Orion applications

Ferranti Orion computers can perform both types of work and two organizations that have recently ordered Orions are The Prudential Assurance Company Limited and the British National Institute for Research in Nuclear Science. The Prudential installation will cost £400,000 and will be employed initially to up-date 1,250,000 policy records kept on magnetic tape.

The second Orion will cost £250,000 and will be used to analyse data obtained from Nimrod, a proton synchroton now being built at the Rutherford High Energy Laboratory, Harwell, Berkshire. A description of Orion was given in *Data Processing*, April-June, 1960.

New I.C.T. computer

The 1301 is the first computer to be announced by I.C.T. since the Company was formed last year. A transistor machine, the 1301 has a magnetic-core store and may be equipped with magnetic tape units. Punched cards are read at 600 a minute and results printed at 600 lines a minute. International Computers and Tabulators Limited and The General Electric Company Limited co-operated in the design of this machine.

Data processing in Scotland

In Edinburgh two insurance companies—the Standard Life Assurance Company and The Scottish Widows Fund and Life Assurance Society—are to establish a jointly owned computer service centre equipped with a Ferranti Pegasus 2 computer. The machine will cost £150,000 and is to be delivered in the summer of 1961.

Initially it will be used for valuation and re-costing of group pension schemes (an article on group pension schemes appears on page 188 of this issue).

Sorting the mail

Postal authorities in both Great Britain and the U.S.A. are experimenting with automatic letter sorting systems. A brief account of an experimental address reader being developed for the United States Post Office is given on page 184 of this issue. In Great Britain a different approach has been adopted. It is proposed that code marks should be printed on the envelopes—maybe in fluorescent ink—when the letters are sorted for the first time. These marks would then be read by machines and the letters sorted automatically during subsequent operations. It is also proposed that the present method of addressing letters should be changed. Destinations would be indicated by mixed alphabetical-numerical code groups—for instance NGM.462, where NGM indicates Nottingham and 462 the street and house number.

Xerographic document copier

Fulfilment of an ambition. Xerography was discovered in the late 1930s by Mr. C. Carlson who was trying to devise a means of copying documents that dispensed with wet chemicals. Now an automatic xerographic document copying machine has been successfully developed. Designed and marketed in the U.S.A. by Haloid Xerox Incorporated, this machine—the XeroX 914 office copier—is being built in Great Britain by Rank-XeroX Limited.

The machine is to be supplied on a monthly rental basis (£30 per month in Great Britain). Included in the rental are the first 2,000 copies. A charge of 3d. is made for all subsequent copies. When 250 a day are produced, allowing for the price of consumable items, each copy costs approximately 4d.

Administration of group

Use of a Leo II computer by the Eagle Star Insurance Company to up-date insurance records and produce actuarial statistics

Clerical work associated with the administration of group pension schemes was increasing in volume and complexity so rapidly that the Eagle Star Insurance Company believed that a computer could help with this work. It soon became apparent, however, that the job did not justify the purchase of a large computer solely for this purpose. On the other hand, the job could not be performed on a small computer or punched-card installation. Consequently Leo Computers were requested to investigate the situation and devise a means of handling the work as a computing service job. Three main programmes were developed and now the routine clerical tasks connected with the numerous group pension schemes administered by Eagle Star are performed on a Leo II at Leo Computers' Queensway service centre in London. In addition, many essential actuarial, accounting and other statistics are produced

SINCE the end of the last war the number of group pension schemes has grown rapidly and the increasingly intricate nature of some of these, together with revision of older schemes, has enormously increased the volume of work to be done. The Eagle Star Insurance Company administer a large number of pension schemes for various companies involving the annual up-dating of thousands of individual records. As a result of the concessions contained in Great Britain's 1956 Finance Act, the rates of many of these schemes were reduced and it was then that Eagle Star began an investigation to see if a computer could be employed on this work. It soon became apparent that the amount of data processing to be performed, although considerable, was insufficient to justify the purchase of a large computer. Yet, at the same time, it was considered that a small computer or punched-card calculator would have neither the capacity nor the ability to perform, in one operation, all the calculations required. Consequently, in 1957, Eagle Star asked Leo Computers Limited to investigate the problems and evolve a method of handling the work as a computing service job.

It was specified by Eagle Star that the computer should be able to calculate renewal premiums, surrender and paid-up values of policies, valuation reserves and the effects on the various funds of the deaths expected according to the mortality tables in current use. The computer was also required to prepare punched cards that would provide information for the employer and the employees and, finally, the computer was to produce all the necessary statistics needed for the Board of Trade returns and for valuation purposes.

In order to meet these requirements Leo Computers reviewed the work performed over the previous 25 years and the clerical methods used to operate the schemes. As a result of this investigation, three main programmes were written: an introductory programme to convert all previous information about a scheme into a suitable form for the computer, a renewal programme for up-dating employees' records and a statistical programme to produce all the facts and figures required by the Board of Trade and the Company's actuaries.

Investigations started in January, 1958. The programmes were written over a period of six months and before January, 1959, the first computer runs were completed.

No two pension schemes are alike, but the essential details common to most schemes will be described briefly to indicate the nature of the data processing problem. Each member of a group pension scheme normally contributes towards the cost of his pension and the company employing him provides the balance and at the same time usually pays, in full, for any life insurance benefits covered by the scheme. On reaching retirement age, the employee receives

pension schemes by computer

a pension, the value of which depends upon his earnings, year by year, during the period of his employment.

Once a year, contributions to the fund are reassessed and the records are up-dated. The complexity of the problem arises from the fact that not only do employees' earnings vary from year to year, but members leave the scheme, others die before reaching retirement age and new members are continually being accepted. A further difficulty, as far as Eagle Star is concerned, is that the Company administer a large number of different group pension schemes involving thousands of members and, although the schemes are similar in concept, each has its own minor variations.

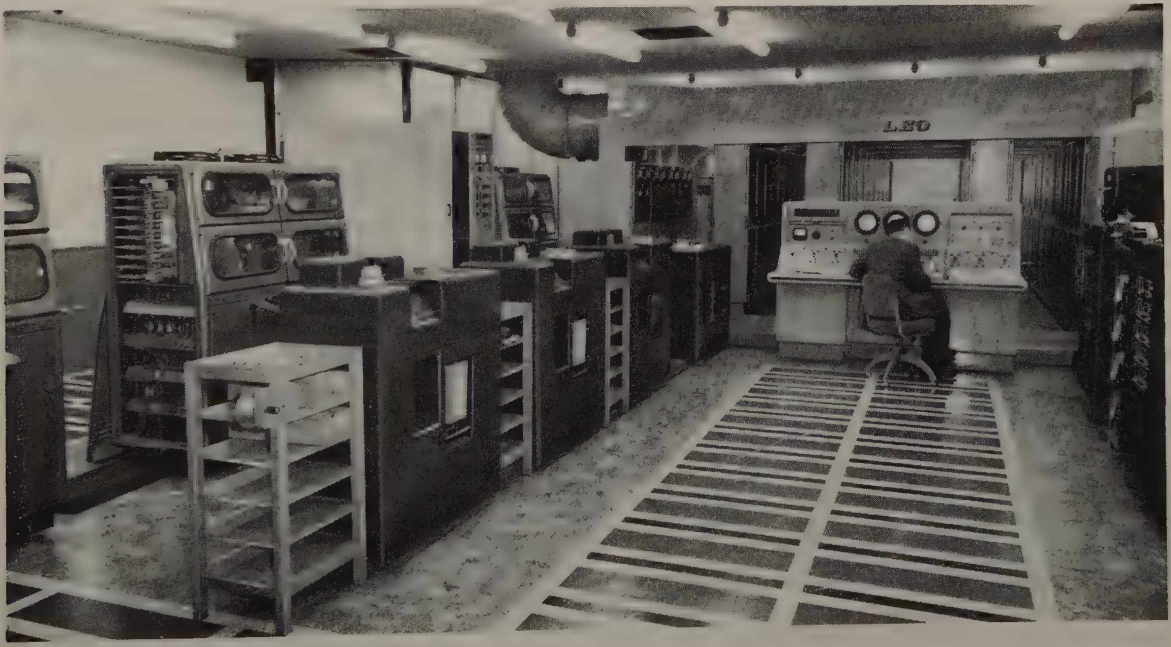
When the computer investigation was started, this question of innumerable differences between basically similar schemes provided the major difficulty that had to be overcome. Obviously, as the records of each scheme are only up-dated once a year, it was not feasible to write a separate programme for each one.

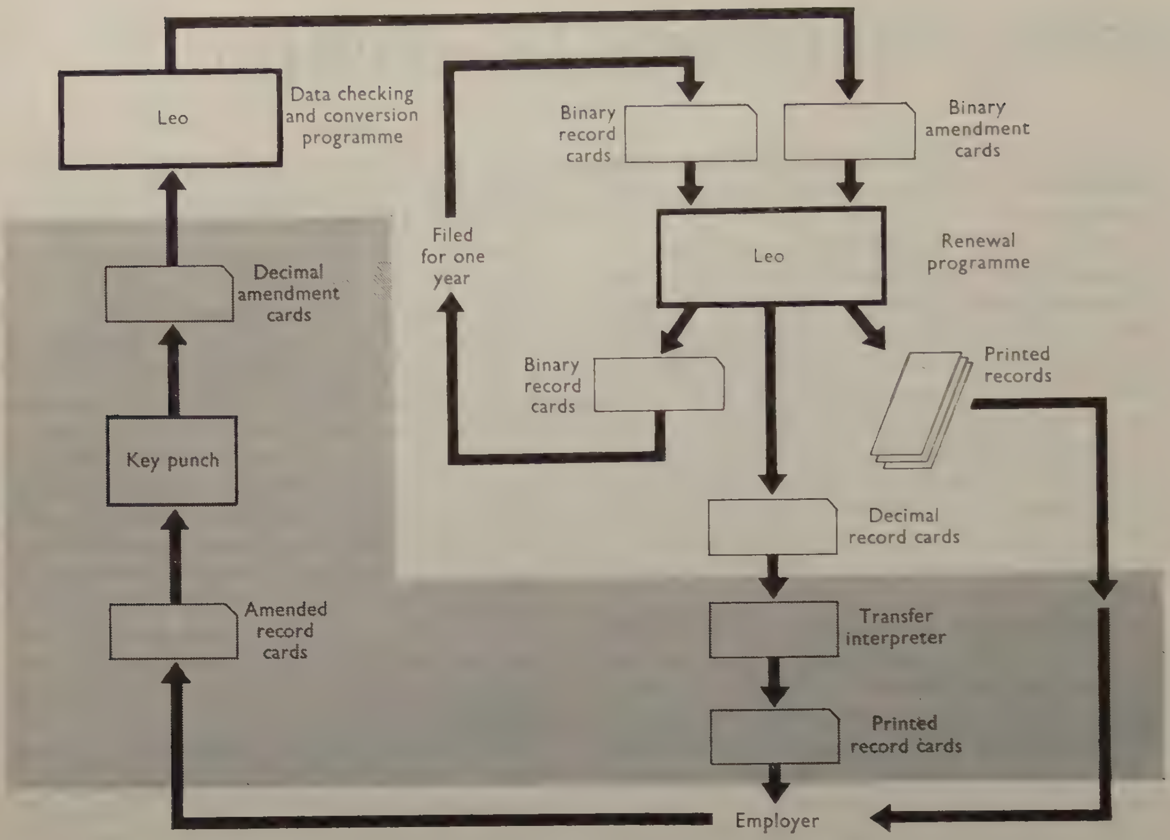
After much work, a single programme called the renewal programme was devised which could handle all schemes of the same basic type, yet take account of the differences between them. This was something of a programming achievement because it was by no means easy to prepare a set of computer instructions that was consistent and, at the same time, would allow for the many possible variations.

In practice, two operations are necessary to prepare the computer for processing the records of a particular scheme. First, the programme instructions are read into the machine from a pack of punched cards and, secondly, a set of numerical constants is entered. These constants define the limits, the method of calculation and those parts of the programme which are applicable to the particular pension scheme to be handled. Thus, by merely changing the values of the numerical constants, this one renewal programme can be made to cope with each of the many different pension schemes handled.

Before group pensions work could be transferred to Leo, the existing data had to be prepared in the required form. Many of the pension schemes had been running since 1934, and it was found that it was not sufficient to take the 1959 figures and transfer them directly

Leo II computer installation at the Queensway service centre





Data processing sequence. The shaded portion of the diagram indicates the operations performed by the Eagle Star Insurance Company. Pension records are up-dated by Leo at the rate of 1,200 *an hour*

to the computer. So the computer was provided with the basic data, current when each member entered the scheme, together with information covering all changes arising from increases in salary, etc., in each of the years that followed. Then the computer proceeded to up-date the members' records, year by year, until it arrived at 1959.

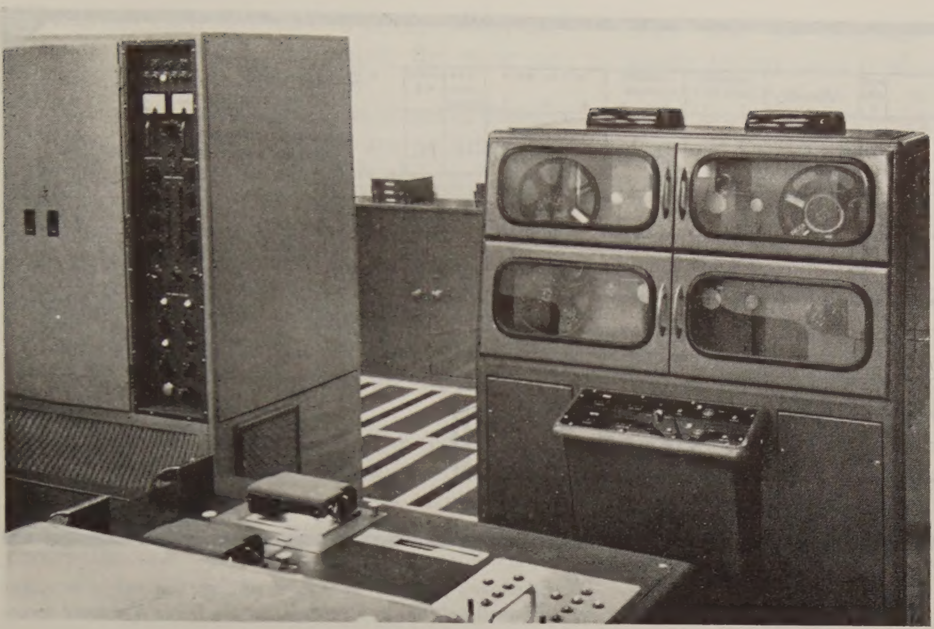
Checking computer programme

The computer was also provided with the equivalent figures for these years that had been calculated by the clerical methods that were now being superseded. Thus not only did the computer derive figures which were consistent, but these figures could be compared with those obtained previously. Consequently, in one operation, a check on the accuracy of the computer programme was obtained and also on the clerical work performed in the past. Finally, because the computer programme is designed to accomplish more than the clerical procedure it replaces, historical statistical records of each scheme were obtained that had never been available before.

No printed records are produced by the introductory programme just described; all data are recorded in punched cards.

Although the Leo II on which this work is performed is equipped with Decca twin-deck magnetic tape units, all group pension data are recorded in standard 80-column punched cards which are held on file and carried forward from one year to the next.

There are two main reasons why magnetic tape is not used. First, if costs are to be kept at a minimum, it would be necessary to record data concerning many pension schemes on one tape. Consequently, when the accounts of one scheme were to be up-dated, time would be lost searching the tape for the appropriate records.

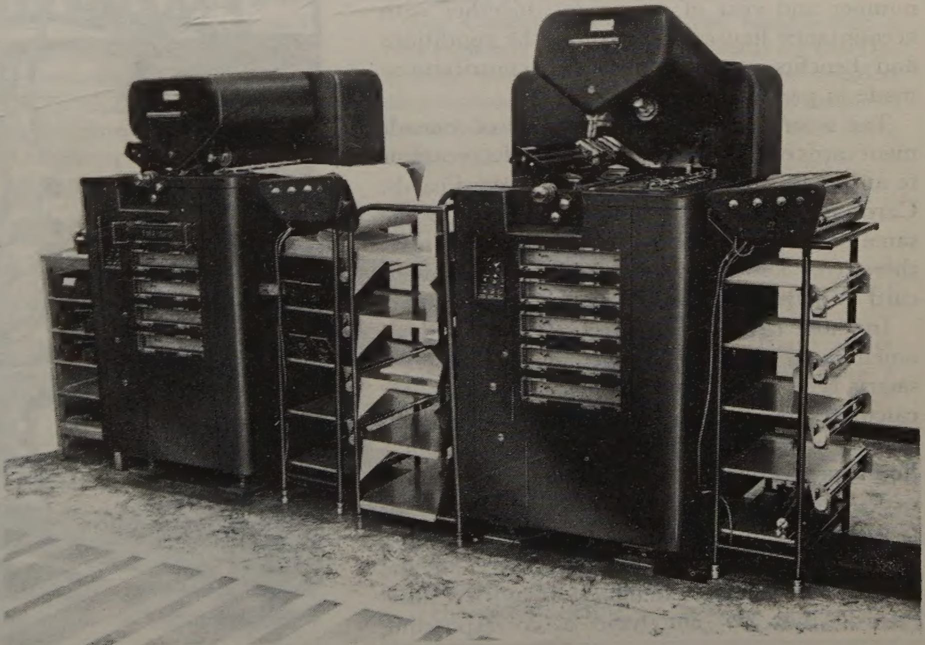


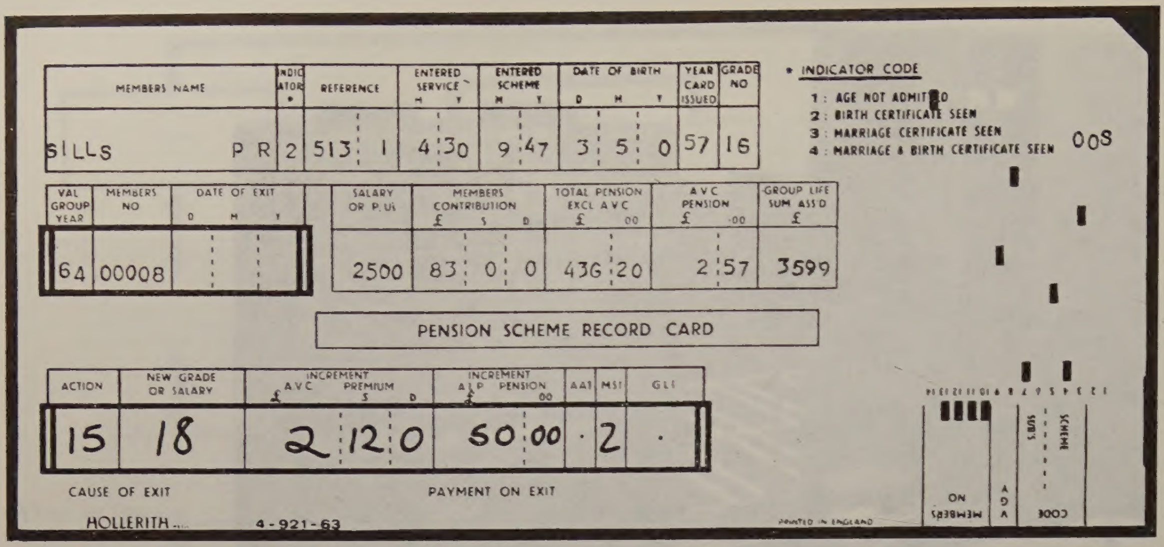
Although not used for insurance work, the computer is equipped with Decca twin-deck magnetic tape units

Secondly, the various computer operations overlap. While data about one member are being read from a punched card, the records of a second member are being up-dated by the computing circuits and the revised data about a third member are being punched into a new card. As these three procedures are performed simultaneously, and as a considerable number of calculations is involved which take longer to complete than the reading or punching operations, no advantage is gained by obtaining the data from magnetic tape at high speed instead of from punched cards at a lower speed.

Once all the data have been prepared for the computer by the introductory programme, the annual renewal runs are performed on the Leo as a standard and unvarying routine. First, the programme is read in together with the appro-

Results are printed by I.C.T. Samastronic line printers. Lines containing as many as 140 characters are printed at the rate of 300 a minute





MEMBERS NAME	INDICATOR *	REFERENCE	ENTERED SERVICE M Y	ENTERED SCHEME M Y	DATE OF BIRTH D M Y	YEAR CARD ISSUED	GRADE NO
SILLS P R	2	513 1	4 30	9 47	3 5 0	57	16

* INDICATOR CODE
1 : AGE NOT ADMITTED
2 : BIRTH CERTIFICATE SEEN
3 : MARRIAGE CERTIFICATE SEEN
4 : MARRIAGE & BIRTH CERTIFICATE SEEN

00S

VAL GROUP YEAR	MEMBERS NO	DATE OF EXIT D M Y
64	00008	

SALARY OR P.U's	MEMBERS CONTRIBUTION £ S D	TOTAL PENSION EXCL A V C £ 00	A V C PENSION £ ·00	GROUP LIFE SUM ASS'D £
2500	83 0 0	436 20	2 57	3599

PENSION SCHEME RECORD CARD

ACTION	NEW GRADE OR SALARY	INCREMENT A V C PREMIUM £ S D	INCREMENT A L P PENSION £ 00	AAI	MSI	GLI
15	18	2 12 0	50 00	·	2	·

CAUSE OF EXIT

PAYMENT ON EXIT

HOLLERITH ... 4-921-63

PRINTED IN ENGLAND

MEMBERS NO

AGE

SUB'S

SCHEME

CODE

Employee's pension record card. Changes in salary or status are written in the box provided in the lower left hand corner

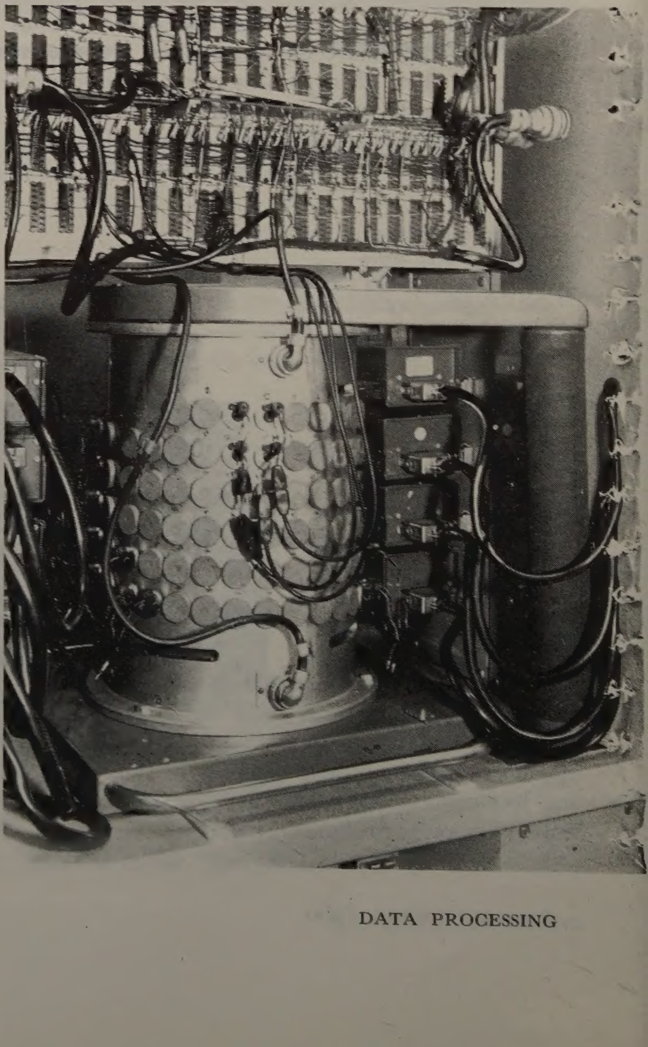
priate constants for the particular pension scheme. Then data read from two packs of cards by two separate readers are fed into the computer.

One pack contains all the employees' data carried forward from the previous year. Usually there is one card for each employee, but, should he have been in the scheme a long time, two cards may be required. Data are recorded in these cards in binary form. Information punched in the cards includes the member's number and year of retirement, together with accountancy figures which show the conditions and benefits resulting from the contributions made in previous years.

The second pack of cards consists of amendment cards containing corrections and alterations to any of the data included on the record cards. Cards in the second pack are sorted into the same order as the record cards, but, of course, there will not necessarily be an amendment card to match each record card.

In those cases where a record card and an amendment card, notifying, say, a change of salary, refer to the same employee, the computer calculates the new rates of contribution required and the new benefits. This calculation is not a simple procedure, because the increased amounts depend upon, among other things, the employee's present age and the conditions specified in the table of benefits that apply to the particular pension scheme. Of course, those records that do not have a corresponding

Magnetic drum information store. Up to four of these units may be fitted to a Leo II computer



amendment card still have to be up-dated, the rates of contribution remaining the same as those paid in the previous year.

The revised records are then punched in two new sets of cards. Results are recorded in binary form in one set of cards and in decimal form in the other. In addition, details of current premiums and various accountancy totals and sub-totals are accumulated for record purposes, and these are printed directly on to headed stationery by an I.C.T. Samastronic printer. Carbon copies of these documents are also produced. Members' records are up-dated at the rate of 1,200 an hour.

At the end of a renewal run, the record cards used to provide the input data are discarded. However, in case any queries arise, these superseded cards are retained at the service centre for one year and are then returned to Eagle Star for disposal. The new pack of binary record cards produced by the computer is also retained at the service centre. These cards, of course, will provide the input data for next year's renewal run.

Only selected data are punched in the second pack of decimal cards. Information recorded include the employee's name and code number, year of retirement and the current position of his contributions and benefits. Also recorded in the card are indicators which show whether the member is married and other details of his status. These cards are sent to the Eagle Star office, where they are passed through a punched-card transfer interpreter and the decimal data read from each card are reproduced in print on a second card called the employee pension record card. Packs of these printed cards are then sent by Eagle Star to the employer

LEO II COMPUTER

Leo Computers Limited's new service centre at Hartree House, Queensway, London, W.2, was opened in May, 1959. A Leo II computer is installed there, together with the necessary supporting facilities such as programming and card punching sections. A second Leo II computer installed in the old headquarters of the company at Elms House, Brook Green, is also employed on service work. The time of the original Leo I at Cadby Hall, once employed on service work, is nowadays almost fully occupied in data processing for the parent company, J. Lyons and Company Limited.

The Leo II at Queensway is equipped with I.C.T. punched-card data input-output units and Samastronic high-speed line printers. Lines containing up to 140 characters can be printed at the rate of 300 a minute. A 2,048 word rapid access information store (mercury delay lines) is provided, and Ferranti magnetic drums are used as auxiliary stores. Ferranti photo-electric punched paper-tape readers are also fitted. This particular machine is also equipped with three twin-deck Decca magnetic tape units, although they are not used for the insurance work described in this article.

A wide variety of scientific and commercial jobs is handled at the Queensway centre.

Leo Computers Limited now manufacture a new version of the computer known as the Leo IIc. A large transistorized magnetic-core information store replaces the mercury delay lines and magnetic drum stores of the earlier machines, and a faster arithmetic unit is fitted.

LEO II COMPUTER CHARACTERISTICS

Number system: binary
Mode of operation of arithmetic unit: serial
Times for arithmetical operations:
    + 0·34 millisecond to 0·66 millisecond (0·00034 to 0·00066 second)
    × 0·66 to 3·5 milliseconds (0·00066 to 0·0035 second)
    ÷ 3·5 milliseconds (0·0035 second)
Type of instruction: single address
Word length: 19 or 39 bits
Quick-access store: mercury delay lines of 2,048 words (19 bits each) capacity, plus 14 words (39 bits each) immediate-access store capacity
Auxiliary store: two magnetic drums, each of 8,192 words (19 bits each) capacity. A maximum of four drums each of 16,384 words capacity may be fitted
Backing store: magnetic tape. Data read or written on tape at a speed of 10,000 bits a second
Data input:
    punched cards read at 200 a minute
    punched paper-tape read at 200 characters a second
Data output:
    cards punched at 100 a minute
    printed at 300 lines a minute with 140 characters per line

concerned and provide information about the state of each employee's contributions and benefits. The employer retains these cards and, if a change in salary or status occurs (i.e., the employee receives an increase in salary or leaves the company) this is recorded in a special section provided on the card, which is then returned to Eagle Star before the next yearly renewal run. Amended record cards are returned by the employer only if there has been a change in salary or status.

At the Eagle Star offices these data are transcribed manually into punched cards—the amendment cards referred to previously—which are forwarded to Leo.

To reduce the chance of transcription errors to a minimum, heavy lines are printed on each side of those sections containing data to be transcribed. In this way, the attention of the keyboard operator is concentrated on the important facts.

Both copies of the documents produced by the Samastronic printer during the renewal run are sent to Eagle Star. After the documents have been scrutinized, a portion of the top copy which contains various accountancy and actuarial totals and other statistics required for the office records is detached and, together with the carbon copy, is retained by Eagle Star. The top copy is then sent to the employer. Data printed on this document show the year of retirement, member's number, member's name, year of last change in status, annual contribution from member, special contribution from member, employer's contribution, any special contribution from employer, group life premium paid by employer to provide death benefit for the employee and the total contributions paid by the employee to date (normally returned to him if he withdraws from the scheme). This concludes the renewal programme.

Data checking programme

In the data processing sequence devised, a subsidiary or data checking programme is performed before the renewal programme is run. As its title suggests, the principal object of this programme is to confirm that the data punched in the amendment cards are consistent. Another check carried out is to confirm that all amendment cards have been read. Amendment cards are arranged in batches accompanied by a control card in which the batch total is punched and these two figures are automatically checked by the computer when the cards are read.

One further job performed during the data checking run is to convert the data recorded in decimal form in the cards into the binary form used by Leo. This is done to save time when the renewal programme is run. Consequently one of the products of the data checking programme is a pack of binary amendment cards.

Data relating to new members entering the pension scheme are also introduced during the data checking run. All the relevant information about the new member is recorded in decimal code in a standard card by Eagle Star. These cards are arranged in the correct sequence with the decimal amendment cards and during the data checking run the equivalent binary amendment card is produced.

Actuarial statistics

Finally, to derive actuarial statistics and also to obtain data needed by the Board of Trade, a third programme is performed on the computer. One of the documents printed during this run is a complete list of all persons who have withdrawn from the pension scheme and the reasons for their withdrawal, together with the surrender values to be paid. In addition, valuations are calculated for actuarial use.

Some of the more important statistics produced by this programme are the valuation figures. These are estimates of the value of payments to be made in the following years based on the present expectations of life of the members in the various age groups. The estimated value of future premiums is also calculated, and from these figures the actuarial reserves required to be held in the fund can be assessed. This information provides management with an accurate guide of the progress of the fund.

By using Leo to up-date the insurance records of a large number of group pension schemes, the Eagle Star Insurance Company have relieved their pension department of a considerable amount of routine clerical work. In addition, essential actuarial statistics are produced in a more convenient and comprehensive form.

The work provided by group pension schemes is sufficiently complex to necessitate the use of a large computer, but, on the other hand, the volume is not enough to justify Eagle Star buying their own computer. However, by using, for a few hours each week, the facilities provided by the Queensway service centre all the advantages of computer operations are obtained at a reasonable and economic cost.